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DEPARTMENT OF COMMERCE TECHNOLOGY PROGRAMS AUTHORIZATION

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

REAUTHORIZATION OF THE DEPARTMENT OF COMMERCE TECHNOLOGY PROGRAMS

JUNE 6, 1989

Printed for the use of the
Committee on Commerce, Science, and Transportation

U.S. GOVERNMENT PRINTING OFFICE
27-716 O
WASHINGTON : 1989

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

S261-41

27-716 - 90 - 1

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REAUTHORIZATION OF COMMERCE DEPARTMENT TECHNOLOGY PROGRAMS

TUESDAY, JUNE 6, 1989

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 9:35 a.m. in room SR-253, Russell Senate Office Building, Hon. Ernest F. Hollings [Chairman of the Committee] presiding.

Staff members assigned to this hearing: Pat Windham, professional staff member, and Fiona Branton, minority staff counsel.

OPENING STATEMENT BY THE CHAIRMAN

The CHAIRMAN. Good morning, and welcome to the hearing on the reauthorization of the Commerce Department's technology programs, particularly the programs of the National Institute of Standards and Technology.

Last year, Congress and the Reagan Administration agreed to two far-reaching technology bills. First, among the technology provisions of the Omnibus Trade and Competitiveness Act was one which took the Commerce Department's premier laboratory in support of industry, the National Bureau of Standards, and made it into a new institute with expanded responsibilities and authorities (NIST).

The second piece of legislation the NIST Authorization Act for FY 1989, reorganized the Commerce Department's technology activities and put them into a new Technology Administration to be headed by a new Under Secretary of Commerce for Technology.

In these two new statutes, Congress and the Administration stated that the Federal Government has an on-going responsibility to help develop long-term basic technologies that America needs in order to stay competitive.

We all agree that government has an important role here. This morning we will ask what must be done to carry out that role. Congress has created the necessary programs. Now we must ask what is needed to implement them.

The key question, of course, regards resources and priorities. Can the Federal Government fulfill its responsibilities without new money, without a clear commitment?

This hearing, therefore, will review the Commerce Department's technology programs—what they have contributed in the past to U.S. industry, their present activities, and what needs to be done in the future. We will hear from both NIST's Acting Director and a panel of distinguished outside witnesses. The panel will discuss programs and needs in all three of NIST's current missions—its laboratory program, which provides industry with precise measurement techniques and other "support technologies;" the new technology extension activities; and the new Advanced Technology Program, whose purpose is to encourage and assist new private sector research. All three efforts are vital to rebuilding America's sagging technology base and restoring U.S. technological leadership.

Later this week, several of my colleagues and I will join in the introduction of a bill designed to reauthorize and strengthen NIST and related programs in the new Technology Administration. The bill will include added resources, not only to strengthen the institute's laboratory and extension programs, but also to support industry lab research efforts in such critical areas as advanced electronics and television, superconductivity and advanced manufacturing.

I have an opening statement that Senator Pressler would like to have included in the record.

(The statement follows:)

OPENING STATEMENT BY SENATOR PRESSLER

Mr. Chairman, thank you for scheduling today's hearing. It assumes perhaps a little more importance than the normal NIST reauthorization hearing, since we are in the midst of deciding how we want to approach the federal involvement in high-definition television development. We also need to pay attention to the increasing importance of standards in foreign trade.

American companies, particularly small companies like most of those in my home state of South Dakota, are often at a disadvantage in international trade because we have not developed a set of common standards with many countries. European countries and Japan, for instance, have set up permanent offices in less developed countries for the purpose of providing assistance in drafting product standards, giving those countries a great advantage over us.

The unfair trade and protectionism we face in the international trade arena leads me to believe that we should do everything we can to streamline involvement in international trade by American companies. Reaching agreements on standards is a key responsibility of NIST for the benefit of American trade.

With that I will close my comments, Mr. Chairman. I look forward to the testimony of today's witnesses.

The CHAIRMAN. Our first witness this morning is Mr. Ray Kammer, long NIST's deputy director and currently its acting director. With him are the heads of the NIST's five main divisions. They are available to answer any questions. Mr. Kammer, we would ask that you come forward please and we would be glad to hear from you and have your testimony. Your statement in its entirety will be included in the record and you can highlight it as you wish.

STATEMENT OF RAYMOND G. KAMMER, ACTING DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, DEPARTMENT OF COMMERCE; ACCOMPANIED BY DR. DONALD R. JOHNSON, DIRECTOR, OFFICE OF TECHNOLOGY SERVICES; DR. JOHN W. LYONS, DIRECTOR, NATIONAL ENGINEERING LABORATORY; DR. LYLE H. SCHWARTZ, DIRECTOR, MATERIALS SCIENCE AND ENGINEERING LABORATORY; JAMES H. BURROWS, DIRECTOR, NATIONAL COMPUTER SYSTEMS LABORATORY; AND DR. HARRY S. HERTZ, ACTING DIRECTOR, NATIONAL MEASUREMENT LABORATORY

Mr. KAMMER. Good morning, sir. The first thing I would like to mention is we put our new logo on the front of our testimony

The CHAIRMAN. Well, we have that much, but we have got a ways to go.

We are great at symbols and signs in Washington, but short on money.

Mr. KAMMER. Well, this is a very inexpensive logo.

The CHAIRMAN. Yes. It has to be.

Mr. KAMMER. My purpose here today, of course, is to request the authorization of appropriations for NIST for the fiscal year 1990, and this year our request is for $155.6 million and we are asking for increases in measurement research for a chemical process control and quality assurance, light wave measurement technology, high performance composites, high temperature superconductors and bioprocess engineering. In addition, we have proposals in the budget for computer security and to upgrade our scientific computer.

I would like to begin by talking a bit about some of our accomplishments and some of the progress that we have made in implementing legislative mandates that we have been given. First of all, I would like to talk a little bit about the cold neutron research facility. This Committee has been a constant and much appreciated supporter of the cold neutron research facility, and of course the intent of this facility is to give the U.S. a unique capability to conduct research on advanced materials.

Two years ago we let the A&E contract and on January 12th the building itself was dedicated on time, on budget, and we expect to have the first four experimental stations, of a total of about 15, installed and operational by the end of this year.

An important feature of this facility will be that about a third of the stations will be equipped and used by both industry and university and to date Exxon has contributed $500,000, Kodak $250,000, and NSF has just committed to roughly a million dollars a year for the next three years to support academic use of the facility.

I will say a few words about computer security, since this is a piece of recent legislation. We have met all of our first year assignments under the Computer Security Act and NIST and NSA have signed a formal memorandum of understanding to define our responsibilities and we are just beginning cooperation under that MOU, but the initial signs are good and I expect an effective and cooperative relationship with NSA.

Mr. Chairman, I am sure you remember you and Senator Thurmond participating in the announcement last December of the selection of the three organizations that are now NIST regional manufacturing technology centers.

The three centers are the Great Lakes Manufacturing Technology Center in Cleveland, the Northeast Manufacturing Technology Center in Troy, New York, which is run by RPI, and the Southeast Manufacturing Technology Center at the University of South Carolina in Columbia.

We have signed cooperative agreements with all three of the centers and statements of work have been developed and agreed upon and the centers are now operational. Of course, since they are just beginning to get underway their accomplishments are now still before them, but there are some initial signs of progress.

The Cleveland Center has set as a target dealing directly with 2,000 companies during the first year and they hope that 10 percent of those companies will stick with them throughout the duration of the project. They have already established working relationships with 415 mid and small-size companies and they have held training activities like conferences and workshops that about 1,300 people have attended.

The RPI center in Troy, New York, has sent its first personnel to NIST. They spent about a month with us learning AMRF technologies and they have taken back both software and hardware for testing, preparatory to disseminating it to the local environment.

The center in Columbia, South Carolina, is operated of course by the University of South Carolina and the center makes very extensive use of the state's strong technology college network.

Highlights so far include the selection of regional coordinators at three of the technical colleges, and these are at Trident, Greenville and Midlands, who will work closely with the center in the development of training materials to begin training in six technical areas. These areas are going to include computer-aided design and manufacturing and finite element analysis.

The center is also remodeling and installing equipment in excess of $3 million to be used in demonstrations and training and beginning projects in four South Carolina-based companies that employ about 1,000 people.

So we are feeling like we have gotten off to a pretty strong start in all three areas. The selections are all ones that some more familiarity has made us even feel better about the selections than we did last December.

With respect to the advanced technology program, of course we have just recently been authorized to establish such a program and the overall goal is to improve the competitiveness of U.S. business by helping them to commercialize technological innovations and to refine manufacturing technology.

Several of the potential uses of the ATP authority have been in the press lately and one of them, of course, is the American Electronics Association's proposal to establish an advanced technology corporation to guide the development of U.S. industry.

The Administration has not yet determined what the appropriate scope of ATP should be or the best approach to take from their point of view for advanced television issues. The Secretary of Commerce will be announcing policy recommendations on the ATV issue this summer.

I would like to make a few comments on some of the suggestions in the AEA proposal, however. The proposal suggests about a billion dollar program of loans and loan guarantees which would go through the NIST advanced technology program.

One of the ideas is the construction of a world-class industrial infrastructure, preferably new, fully integrated complexes similar to those in Japan, to quote from the proposal.

In my own mind I have some reservations about going quite that far, quite that quickly. It would be an extraordinary societal change for us to decide that the government was going to try to in effect create a vertically integrated industry out of whole cloth and money. Maybe that is where our society is finally going to decide to go, but we are a long way from that decision so far.

The CHAIRMAN. You say that is the recommendation? I am trying to get it clear in my mind. I know that Secretary Mosbacher is going to make a recommendation.

Mr. KAMMER. This was one of the AEA recommendations and it is a very bold and imaginative idea, I suppose. Maybe too bold, at least I am saying for me at the moment. It would be a long way for our society to go. The idea as I understood it was sort of to create the equivalent of the Japanese highly integrated industrial complex and that has not been the way our society has done things up until now. It would be an interesting change.

The CHAIRMAN. I am worried about the competition, not the society. How would you view it?

Mr. KAMMER. Well, I am not personally persuaded that HDTV itself as a product is where we are going to end up. I am—there is—all of our history tells us that our society will take any advance in communications and deploy it very, very rapidly and be very interested in it and it has always been a good financial bet.

Whether the next round of communications advance, which I think is in the cards—I think there is going to be some kind of an advance in image technology, if you will, that is going to be very popular and used by our society. Whether it is HDTV, whether it is digital TV, whether—there are a lot of technically possible ideas that are very interesting.

I am not sure. I doubt if anybody is really sure. There are people who are pushing different ideas, but I do not know if they are confident yet.

The CHAIRMAN. Well, while IBM is not in the television business, they do seem pretty sure. That is why they have been up here testifying. They are not worried about losing their television business because they do not have any. They are worried about losing their edge in computers. They think that the computer technologies going into HDTV will ultimately become crucial—sort of—like the tail wagging the dog of the computer manufacturers. That is why they are up here. IBM is strong in Japan so we do not hear them bashing Japan and all of that.

I want to know how we are going to compete in this particular technology, as you see it. I remember when we had a hearing on Telstar and Chesterton Senator Gore saying, "Would that the greatest advance in communications come at a time when man had nothing to say." Now, would that the greatest advance in communications technology come at a time when America has nothing to do.

I mean, we are going to sit here and worry about the societal differences? I can send you over to Labor and Human Resources to testify on that. I want you to tell me how to compete.

Mr. **Kammer**. Well, what if HDTV turns out to be the equivalent of the video disk rather than VHS, in another technology?

Senator **Gore**. They are coming back now, are they not? The video disk?

Mr. **Kammer**. A new different kind is going to.

Senator **Gore**. I just saw an article last week where they are on the upswing and on HDTV. If you would just let me interject this comment, it is impossible to predict with certainty when or if a particular technology will take off.

The Japanese may well have squandered $900 million in betting on HDTV. But, they do have a pretty good track record of picking winners. They have been associated with some failed bets I don't deny that, but the stakes here are so high and if they are betting this amount of money and resources, and if the market projections are so persuasive, it seems unwise for us to pass it by.

I just wanted to interject that comment.

Mr. **Kammer**. There are a variety of technologies that are going to be common to whatever the product choice ultimately is and those are things which I think our society can bet on with quite a high degree of confidence.

Probably the most obvious one is optical fiber communications, which besides making HDTV or digital TV—some advanced TV—possible, probably creates completely unthought of service industries at the same time, if we ever can run it up to people's houses for whatever economic pretext that it is done under.

After that, I would imagine that one would see an awfully wide panorama of opportunities open up. My advice, that in fact we have also given to Secretary Mosbacher, is to try and identify the underlying technologies, of which that I think is probably the single most important, and to make sure that we push on those.

Maybe—it is certainly above my pay rate to decide how far we go, how far down the product chain, but do not forget to do the things that are going to be common to all of the technologies and that is my primary advice, and that is what I would say bet on.

The **Chairman**. Very good. Go right ahead.

Mr. **Kammer**. Okay. There is one other point about the AEA proposal that I would like to make. There is a point of emphasis in there that suggests that NIST should develop high definition interchange and broadcast standards and recommend them to the FCC, the NTIA and to Congress.

My personal view is that NIST diminishes its ability to work with industry the more it enters the regulatory arena. As soon as we start looking like we are going to tell industry what to do, or we are going to tell regulatory agencies what to tell industry to do, I think industry loses confidence in working with us and I do not think that is a good assignment for us on a fundamental mission basis.

I am not saying our society does not need to make decisions. I just do not think we are the right people to do it.

The **Chairman**. You do not think the FCC should assign frequencies?

Mr. **Kammer**. I think the FCC has an entirely appropriate role. It is when they say that that role will be based upon a NIST recommendation that I get worried. Someone has to make those allocations. There is no other way to do it.

The **Chairman**. Well, there is no other way to deal with the industry unless you know what the ground rules are and what AEA is asking for as a ground rule.

Mr. **Kammer**. I think that is entirely appropriate, but they also suggest that we develop that standard that then the FCC or others would use, and I do not think we should develop the standard—NIST, in particular. It needs to be developed. I am not arguing about that.

The **Chairman**. I thought that was the fundamental mission of the Bureau of Standards.

Mr. **Kammer**. Well, the Bureau of Standards develops standards to help people measure things. It does not develop standards that tell people what to do. The idea is that our standards and information allow you to make your own choices on what you choose to do, including ignore them if you wish.

The **Chairman**. Very good.

Mr. **Kammer**. The reason that I make a particular point of that is that we are beginning to see regulatory assignments crop up a bit more regularly for NIST. Recently there has been fastener legislation that has been considered in the House to develop that would ask NIST to assume a quasi-regulatory function there and I recommend against that, also.

Throughout my testimony I have discussed in turn each of the fiscal year 1990 budget request items and I think that I will leave them for the written record rather than run through them all now.

I would like to give you a little bit more of a view of where I think NIST is and the philosophy that we are trying to use in responding to our mission, especially our expanded mission under the Technology Competitiveness Act.

Of course, this past year has been certainly among the more eventful in our history. We made the transition from the National Bureau of Standards to the National Institute of Standards and Technology and along with the name change we have seen a tremendous enhancement of our traditional measurement mission, to include a more general mandate to improve the competitiveness of U.S. industry. This is an assignment we welcome. This is very consistent with what we have been doing and what we have been trying to do for a number of years and we are eager to try and fulfill this assignment.

To my way of thinking, our mission now has three major elements. The first of them, of course, is measurement and that is providing the scientific data and standards that our economy needs to compete in the world market.

The second mission is technology and we are told to assist U.S. industry in developing and applying emerging technologies to make world-class products.

Finally, of course, we have a technology transfer mission and this includes accelerating the application and the deployment of new technologies both developed at NIST and elsewhere, and many of the aspects of the Technology Competitiveness Act that are new are really new tools that are given to us to help accelerate the technology transfer process, if you will.

Competitiveness, of course, I have just used it a number of times and it is hard to have conversations on this topic without using the word. I thought I would define what our view of what competitiveness is, namely that it is the degree to which the United States can produce goods and services that satisfy customers in an international marketplace, while simultaneously improving our real national income.

The other phrase that I have used a lot and will continue to use a lot is world-class products and that may be a slightly less familiar phrase, but in my view of the U.S. economy, if it does not succeed in producing world-class products our future will be one of decline.

The four elements I contend that make a world-class product are first of all, highest quality. Secondly, an advantageous life-cycle cost—not the cheapest product, but an advantageous life-cycle cost; modern features and prompt availability in the marketplace.

With your indulgence I will give you a few examples of what I think those four concepts mean, of world-class, and also what I think our mission means in the context of those products.

First, I would like to talk a little bit about quality. Motorola was one of our three winners in 1988 of the Malcolm Baldrige Quality Award. They did a survey of the quality of U.S. products and services and the result was very disquieting.

The usual defect rate—the generally accepted defect rate for pretty decent performance among U.S.-produced goods and services, according to their survey, is about 6,000 defects per million products, per million services delivered, that sort of thing—6,000 out of a million.

Some of the services they used were like restaurant bills, hotel bills, your prescriptions. Then of course, things like manufacturing products. The more traditional things you would think of, I think, a little easier.

The level of performance Motorola achieves—and I know they are achieving it because of the review we put them through in the Malcolm Baldrige Quality Award—is about three defects per million. That is 2,000 times better. Three versus 6,000. There are a few other American companies that do that and there are a lot of Japanese companies that operate at that level of a few defects per million.

This is the level of quality that I am talking about for world-class. If you cannot compete at this level, you cannot compete.

From our perspective, industry sort of initially went through almost what you would call denial about the quality issue. There really is not a problem. All our products are as good as everybody else's.

Then we saw some companies—I saw. I say, I saw some companies apparently setting out to solve the problem through the strategy of advertising. We are now beginning to see a lot of companies make a different kind of a commitment, one where they realize that quality requires quite a bit more. More time, more discipline, a lot of measurement and a much more systematic approach.

One of the encouraging signs to me this year is almost--it almost sounds perverse, but it is a very large number of companies about to apply for the Malcolm Baldrige Quality Award this year. It was apparent to us that there were about 150 companies that have made the commitment and were going into the process, that were beginning to drive us crazy asking us questions about details in the process.

We only got 40 applications this year. We got 66 last year. So the number dropped and at the same time the number of copies of our examination form, which is a very long form, that were distributed is 30,000 since January and we will probably distribute another 20,000 in the next couple of months.

That is four times what we distributed last year, and we obviously talked a lot with the industrial people because when we got a reduction in applications, it makes you nervous that you are doing something wrong.

What we concluded and what a lot of the companies I think are coming out to say publicly now is that in a sense it is good news. Companies did a self-diagnosis and they said, we are not going to make it. We are not ready to compete yet.

Now, I am not immodest enough to claim that somehow this was a result of actions of NIST. I think probably the more meaningful influence is the success that our foreign competitors are having in the U.S. market selling their product and I think that is one of the things that probably wakes U.S. industry up the quickest.

But once they are awakened one of the techniques they are using to learn more about quality is the Malcolm Baldrige Quality Award and I think that is a good thing. I feel encouraged about that, and I think two or three years from now I am going to have a different story to tell, I hope—I expect.

With respect to measurement and its relationship to a number of these world class product characteristics that I have talked about, if I may, I will give you a couple of examples. One of them shows where NIST assistance helped a U.S. company incorporate modern features into a new product, and this is in the area of voltage standards, which is a very old technology in some respects. But NIST has developed a superconducting electronics voltage standard, and it is the world's most accurate voltage standard, and it also happens to be at a convenient quantity, which is 12 volts. Previous voltage standards were at a millivolt, which is not what you use for everyday much of anything. And this standard, by being at a very convenient level, allowed the people applying it—in this case, Hewlett-Packard—to apply it with a previously unrealized accuracy. No one had ever come close to getting this accuracy into a product. And HP, in a publication called the Hewlett-Packard Journal, recently in April very generously acknowledged that they could not have done it without us, and I like to hear that. And it is a modern feature that they never would have been able to achieve, and it will allow them to compete on a world class basis.

Another example is in the area of magnetic media. This is a $40 billion industry, and it is very sensitive to the quality of the product that is manufactured. Also, the density of the data that you store in this magnetic media doubles about every 2½ years, which just seems unbelieveable. It is unimaginable how hard they have to work to do this. Right now they are getting about 10 million pieces of information stored on every square inch of magnetic media, 10 million; and the higher the density, the cheaper the cost for storage, the more rapidly you could access the information. But this drives the heads that you have to use to read the information.

There are so many allied technologies associated with this, it is very, very complex. And one of the problems they were having was that the magnetic media storage industry was running into fundamental limits where they could not see the bits any more that they were trying to store with, and when you cannot see something, it is pretty hard to design it any better. And we developed an instrument, the name of which is not very intuitive; it is called the scanning electron microscope with polarization analysis. And I think I will spare telling you how it works, but say that it allows you to map magnetic media literally at an atomic level, at the level of the individual magnetic bits. This is as low as you can go. I mean, this is the ultimate instrument for these people, and we invented it; and Honeywell, Control Data, Westinghouse, and Digital Equipment, and a lot of other people have cheerfully been paying $3,000 a day to come in and use the facility, and have been very generous in their praise to us, in telling us that there is no way that they could have done this themselves.

Not only that, but the people that did this are among our most basic research people. They are very fine individuals. They did something else that I do not think many other institutions would have done. They took time out from their research to work with Perkin-Elmer. They are the best U.S. machines on the market that could be adapted for this purpose. There are machines that preceded those that you can use after you put attachments on to make into this new device. But they are not made in this country.

The most straightforward thing to have done would have been to purchase the machines from competitor countries and adapt them to this new device, but instead, we went to Perkin-Elmer, and said if you would like, we would like to work with you, and we will help you make your machine into the machine that will do this. And this is a new feature that no one else will be able to compete with. And they are about ready to come out with their commercial version, and so I am very pleased with that and very proud of it.

The CHAIRMAN. What is the difference between the request made for HDTV? Why did we not wait on private industry to develop that?

Mr. KAMMER. Well, the actual technology that we have developed is the technology to see these magnetic bits, if you will. Now, what they are going to do with them, what kind of magnetic media they build—will it be these discs? It might be. It is a pretty good guess, actually. Will it be the traditional tape or that kind of thing? I have no idea. I mean, I have some opinions.

But you have before you a man who to this day would not fund the hoola-hoop. I have no idea why the first one sold. And it is the difference between the technology. The marketplace should use it however it wants, and I wish them well. And I know it is a valuable technology. Data storage is not a controversial issue, you know.

Just like improved communication technology is going to be very attractive, and people are always going to be interested in buying better communication technology. Better magnetic media, better data storage is certainly a technology, but how it gets applied, I do not personally feel comfortable predicting what way or what embodiment of the technology the products will take. So that is the distinction I draw.

The **Chairman**. Very good.

Mr. **Kammer**. In 1987 the Department of Commerce released a report on emerging technologies, and we said in that report that we reckoned that these technologies would have a very large impact on our economic lives over the next several decades. And the list of those is not an unfamiliar list, I am sure. There were seven: advanced materials, electronics, automation, biotechnology, computing, medical technology, and thin layer technology.

An interesting point: the report, as released, first did not include high temperature superconductors, and we put out an amended copy. But the point, the reason why I bring that up is we are never going to predict them all, and I just think that is great. I mean, the more new technologies that come about, the better; but one never wants to be too confident that one knows what the future is.

We have now been asked by Secretary Mosbacher, as I know he told you recently, to update this report, to do a new report, and to try to involve industry in the development of the new report. About 40 or 45 percent of our money is in the seven emerging technolgies that I listed, and a good example of that is, in the area of advanced materials, is advanced metals. And one of the ways that you can make advanced metals is from a powder, and you take a powder, and you melt it, and you fire it through sort of a supersonic device that atomizes it, and as you recondense the droplets, you can then go into a form of rapid solidification that gives you products that are nearly the shape of the final desired product. You do not have to file off rough edges, or metal cut them, or the like; and because you have done it from this powder, interestingly, you can get things such as improved strengths to weight, improved fracture toughness, some unusual magnetic properties that would be good for transformers, resistance to heat, resistance to friction, and resistance to wear. All in all, a pretty nifty process with a lot of promise.

More than a science right now, but the potential is there. And these advantages add up to improved quality, of course, and improved life cycle cost. And one of the things we are trying to do—we are not alone in appreciating the possibilities here—but we are trying to apply what we are calling intelligent processing of materials to carry this technology a step further, because the success in producing a final product is very sensitive to a carefully controlled process that you go through, the metal process, the metal.

And it turned out that the concepts that we developed in the automated manufacturing research facility are equally applicable to this process. The computer control theory and the sensor feedback loops are the same. And so we have what we regard as a fairly sophisticated and mature technology that we can now apply in a new arena, and we are pretty excited about that. We formed a consortium with a number of industrial partners to use this idea, and we are optimistic that this will be successful.

If I may, I will speak just briefly now to technology transfer, which, of course, includes serving sometimes as a conduit, and sometimes we transfer our own technology, and sometimes we are a forum for others. The key to this process, I believe, is our third party objectivity, our lack of a proprietary interest in the product, that allows many industrial firms to tell us what they are doing and be relaxed that they are not creating a new competitor in the process of doing it.

The reason why I mentioned product standards, which is a very old concept, is that it is one of the keys to promptness in the marketplace, to getting to the marketplace fast. And I think everybody is familiar with the sort of, at this point almost old, saw that the Japanese get a car designed in three and a half years, and the United States gets one designed in five years.

One of the keys is common design standards, common product standards, common formats for use in storing data and accessing the data. And one of the common formats that we are becoming a strong advocate for is Product Description Exchange Specification, or PDES; and this allows people to create data, to store it, exchange it; it does not matter what the data is. And in each step carry the design data along, carry the instructions for machining, perhaps, of the part, or for some other kind of processing strategy for the part. And it is neutral to the technology. It is purely a format. It is what we hope eventually gets into the blueprints, and pieces of paper, and redesigning at various steps. And we think this may be the right concept.

We have created a number of industrial forums that we are working with. Some were created by industry, and we went to them, and we are trying to organize them and coordinate them. And, in fact, recently NIST has been named by the industrial consortium in the form of the Automated Manufacturing Research Facility as a national testbed for this idea.

I think I will stop there and give you an opportunity to ask me and my peer group some questions.

[The statement follows:]

STATEMENT OF RAYMOND KAMMER, ACTING DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, DEPARTMENT OF COMMERCE

Mr. Chairman, Mr. Danforth and members of the Committee:

I am pleased to appear before you today to request authorization of appropriations for the National Institute of Standards and Technology (NIST) for the fiscal year 1990.

Accompanying me is Dr. John Lyons, the Director of the National Engineering Laboratory; Mr. Jim Burrows, the Director of the National Computer Systems Laboratory; Dr. Harry Hertz, the Acting Director of the National Measurement Laboratory; Dr. Lyle Schwartz, the Director of the Institute for Materials Science and Engineering; and Dr. Donald Johnson, who will be the Director of Technology Services under the new NIST organizational structure that is now before you.

This year the President is requesting $155.6 million for the National Institute of Standards and Technology.

Measurement is vital to all segments of the United States' industrial economy to assure quality and cost competitiveness of high-technology products and services. This request recognizes NIST's valuable and unique role in providing measurement-related scientific and engineering research and services to support U.S. industry, government, and science. In recognition of the Nation's increased dependence on technology-based trade, NIST has focused many of its proposed initiatives on emerging technologies and on process control and quality assurance techniques needed by U.S. industry to accelerate the commercialization of new high-technology products and services.

Our request is responsive to the recommendation contained in the most recent report of John Young's Council on Competitiveness that the Congress "increase funding for government programs that have high leverage in enhancing the commercial application of technology." The Council's report specifically recommended that "systematic increases should be sought for the National Institute of Standards and Technology (NIST), which is the primary Federal laboratory with an explicit mission to aid U.S. industry."

We are asking for increases for measurement research in chemical process control and quality assurance, lightwave measurement technology, high performance composites, high-temperature superconductors, and bioprocess engineering. Increases are also being requested for computer security and for an upgrade to our scientific computer. Some offsetting decreases are included in the overall request.

Each of the budget initiatives will be discussed in detail later in this statement. First, I would like to report to you on some of our accomplishments and on implementation of some of the legislative mandates that we have been given.

Cold Neutron Research Facility

Cooperative research with the private sector continues to be a "way of life" at NIST. I would like to illustrate with a brief review of the history and status -- a real success story -- of one of our largest recent projects. The NIST Cold Neutron Research Facility (CNRF) adjacent to our Research Reactor at the Gaithersburg site, when fully completed in 1993, will provide a vitally needed new national capability for measurement research on a variety of advanced materials (e.g., ceramics, polymers, proteins, and superconducting and magnetic materials). When it is operational as a national user facility we expect it to attract perhaps hundreds of private-sector users every year, some of whom will be engaged in proprietary research.

The architectural and engineering design contract for this unique facility was awarded about two years ago. The building was dedicated Jan. 12, 1989, and we expect the first four experimental stations (of a final total of 15) to be installed by the end of this year. It is important to note that one-third of the stations will be equipped and used by both industry and universities. To date, Exxon has contributed $500 thousand, Kodak $250 thousand, and the NSF $996 thousand for FY 1989. The NSF contribution is for the first year of a three-year agreement.

Reports Requested by the Technology Competitiveness Act

Congress has asked for a number of reports, including the development of an organizational plan for NIST. Most of the reports are completed and several have already been sent to you. The new organization plan for NIST that you now have before you was prepared after consultation with the Visiting Committee on Advanced Technology. The re-constituted Visiting Committee also recently submitted its first annual report to the Secretary of Commerce, who forwarded it to you, and has conducted its second quarterly review of NIST programs.

Computer Security

The Computer Security Act of 1987 (P.L. 100-235) assigned NIST the responsibility for dissemination of computer security techniques for Federal unclassified computer information systems. The well-publicized computer virus attack on a national computer network several months ago underscores the importance of NIST's role in promoting cost-effective computer security. NIST has met all of its first year assignments under the Computer Security Act. In particular, we are conducting, jointly with the National Security Agency (NSA), a review of the 1,800 security plans received to date. NIST and the NSA have signed a formal Memorandum of Understanding to define responsibilities of both organizations. We are just beginning cooperation under the MOU, but the initial signs are good. I expect a productive cooperative relationship with NSA.

Regional Manufacturing Technology Centers

Mr. Chairman, you and Senator Thurmond participated in announcing last December the selection of three organizations to become the first NIST Regional Manufacturing Technology Centers (RMTC). The goal of these new RMTC's is to assist America's small- and mid-size manufacturers in becoming more competitive by upgrading the technological skills of their workforce and by adopting modern automated manufacturing technology. This will include, where appropriate, the transfer of technology from NIST's Automated Manufacturing Research Facility. The December announcement was the culmination of an intense and thorough competitive process that dealt with thirty-six proposals -- reviewed by the National Research Council -- and numerous site visits.

The three RMTC's are the Great Lakes Manufacturing Technology Center in Cleveland, Ohio, operated by the Cleveland Advanced Manufacturing Program (CAMP); the Northeast Manufacturing Technology Center in Troy, New York, operated by the Rensselaer Polytechnic Institute (RPI); and the Southeast Manufacturing Technology Center at the University of South Carolina in Columbia. Cooperative agreements with all three of these centers have been signed, statements of work have been developed and agreed upon, and the Centers are operational. State and local governments, and industrial and academic partners are now providing at least half the total funds, and the Centers are to become self-financing at the end of six years.

While the targeted industries in the regions of the three NIST Centers will require somewhat different emphasis, some activities are common to all. The central activity is working hands-on with small- and medium-size firms to determine their particular technology needs, and to help develop a technology up-grade plan that makes business sense. The Centers will then assist these firms in business planning and in obtaining financing to make the up-grade possible, and support implementation of the new technology. This work is carried out by teams from the Centers that include manufacturing, business, marketing, and training experts. The NIST Centers will work closely with community colleges and local technical institutes to train the workforce in the use of modern manufacturing technologies. In addition to funding, NIST contributes its reservoir of technological strength and overall program management.

Each of the Centers also has a unique approach to the particular problems associated with the industry in its service area, and I would like to share some of their initial experiences with you.

The Cleveland Center uses a variety of mechanisms, including surveys, to identify appropriate firms for collaboration. Their target is to deal directly with 2,000 companies during the first year, 10 percent of which will remain involved throughout the project. Accomplishments thus far include establishment of working relationships with 415 mid- and small-size manufacturing companies, and the involvement of more than 1,300 people in training activities (e.g., workshops and conferences) in new manufacturing processes and technologies. The initial accomplishments to date speak well of the ability of the CAMP to begin providing immediate services to area manufacturing companies even before the program is fully staffed.

The RPI Center in Troy, New York, uses the New York State Industrial Innovation Extension Service for its outreach network. The mode of operation for this Center includes accessing technology from the NIST Automated Manufacturing Research Facility (AMRF), testing appropriate NIST technology in-house at RPI, and then transferring and testing the appropriate technologies at selected sites. To date several RPI personnel have spent four weeks at NIST learning AMRF technologies, and have taken back both software and hardware for testing.

The Center in Columbia, South Carolina, is operated by the University of South Carolina. The Center makes use of extensive support from that state's very strong Technical College Network. A detailed questionnaire will be used to survey a very large cross-section of small- and mid-size manufacturing companies to identify manufacturing problems, with follow-on interactions emphasizing demonstrations of possible solutions and training. Highlights thus far include the selection of regional coordinators at three technical colleges (Trident, Greenville, and Midlands) who will work closely with the Center, and the development of training materials to begin training in six technical areas such as computer aided design and manufacturing and finite element analysis. The Center is also remodeling and installing equipment in excess of $3 million to be used for demonstrations and training, and beginning projects in four South Carolina-based companies employing approximately 1,000 people.

Each of these three Regional Manufacturing Technology Centers has developed a specialized mechanism for reaching a large audience. At the CAMP, problems are being solved at the level of individual firms. Through mechanisms such as workshops, the solutions developed can then be made available to large numbers of manufacturing companies. The RPI Center is focused on moving advanced manufacturing technology into commercial products that can and will be commercially supported. The South Carolina Center has negotiated an agreement with an organization of the Southern Growth Policies Board to establish technology transfer linkages into each of the fourteen southern states. Through the common management and liaison linkages of NIST, these three Centers will be able to incorporate successful concepts from each other into their own working models. For example, the industrial survey being tested by the South Carolina Center will be adopted by the other Centers. This sort of linkage, assuring maximum leverage and success, is achieved by regular monthly meetings of the Center managers, together at rotating sites, with the manager of the NIST RMTC program.

Center for Non-destructive Evaluation and Testing

Our 1989 appropriation legislation provided for the establishment of a Center for Non-Destructive Evaluation and Manufacturing at Iowa State University and earmarked $7.5 million for this special project over three years, to be matched by $1.5 million from Iowa State and $650,000 from Northwestern University. A cooperative agreement establishing this Center was entered into in January 1989. The goal of the research program is to improve the quality of U.S. manufactured goods by developing computer assisted technology that integrates product design, quality control, and manufacturing. In April of this year participating technical staff from Iowa State and Northwestern visited NIST laboratories to discuss potential areas of cooperation, and NIST staff visited Iowa State in May to continue the interaction. We at NIST and ISU expect this to be an effective and productive relationship.

Advanced Technology Program

As part of its new mission, NIST was authorized by the Technology Competitiveness Act to establish an Advanced Technology Program (ATP), the overall goal of which is to improve the competitiveness of U.S. businesses by helping them to commercialize technological innovations and refine manufacturing technology. Several potential uses of the ATP authority have been much in the press lately. One is the American Electronics Association's proposal to establish an Advanced Television (ATV) Corporation to guide the development of the U.S. industry.

The Administration has not yet determined the appropriate scope of an ATP or the best approach to advanced television issues. The Secretary of Commerce will be announcing policy recommendations on the ATV issue this summer. However, I might comment on a few of the suggestions in the AEA proposal.

The AEA proposal suggests a $1 billion program of loans and loan guarantees, funneled through the NIST Advanced Technology Program, for the construction of world-class industrial infrastructure, preferentially "new, fully integrated complexes similar to those in Japan." Whatever the outcome of the Secretary's review, the NIST ATP program, as I understand the intent of Congress, was established to support development and commercialization of technology at a stage well short of large-scale manufacturing. The AEA proposal also suggests that the NIST Manufacturing Technology Centers (MTC) program should "....identify, develop .... [and] demonstrate appropriate flexible manufacturing systems that could be adopted by prospective U.S.-based entrants in the ATV business." The focus of the NIST MTC program is to encourage the adoption by U.S. companies of modern, but off-the-shelf, manufacturing technology, not to engage in the development of advanced manufacturing systems.

I do not wish to sound negative -- the emerging technology underlying digital data and information processing, of which HDTV is but a small and near-term popular focus, may eventually wrap the world in a web of fiber-optic cable. We would very much like to contribute our talents to the development of reference standards and measurement techniques for electronics, optics, networks, and magnetic media; for production processes; and for the transmission, interchange, and conversion standards that will make this revolution happen. There is good work for us at NIST to do, work in the long-term development of an enormous range of new technologies, and work ideally suited to our mission. Unfortunately, this is obscured by the pointed emphasis in the AEA proposal on assigning NIST responsibility for near-term advanced manufacturing facilities, on the one hand, and a standards mission narrowly focused on regulatory broadcast standards, on the other.

I have particular difficulty with this last element of the AEA proposal-- that "NIST ..... should develop high definition interchange and broadcast standards ..... and recommend them to the FCC, NTIA and Congress ..... ." Any suggestion that NIST enter the regulatory arena, as by recommending broadcast standards to the FCC, conflicts with our traditional role as neutral third party. To participate in the regulatory process would ultimately make it impossible for us to fulfill our fundamental mission.

Suggestions that regulatory functions be assigned to NIST keep cropping up. As I testified during the recent debate over proposed fastener (bolt) legislation, NIST is quite eager to help develop standard techniques and tools by which reliable measurements can be made, but we should never become the body charged with responsibility for applying these techniques to discriminate for or against particular products in the marketplace. The first task is definitely within our mission, the second is a regulatory function and I believe incompatible with the mission of NIST.

Details of FY 90 Request

Let me now move on to a summary of the elements of the FY 1990 budget request. In order to provide the measurement foundation needed to accelerate the development and use of science and technology by industry, NIST must continue to anticipate technological innovation. The only way to keep pace with the increasing sophistication and pervasiveness of technology is through selected program revisions and expansions that reflect key growth areas of the economy. We have done this to the best of our ability by redirecting our own resources and using resources provided by other agencies.

The President's FY 1990 budget request for NIST contains proposed increases for the most critical areas of research, along with decreases reflecting overall fiscal constraints. These correspond to a Presidential priority that I strongly support -- that NIST's in-house, measurement-related research and services must be maintained at full strength. This request, which represents an increase of approximately eight percent over the FY 1989 appropriation for NIST's intramural program, will accomplish this. These proposed increases to the Institute's FY 1989 budget include:

o Process Control and Quality Assurance (16 positions and $2.1 million): Chemical measurement technology, standards, and reliable data are crucial to enhance productivity, introduce new technologies, and meet the competitive challenge in a range of international markets. For many emerging technologies, no chemical measurement base exists. This request would allow NIST to advance the chemical measurement science needed for new high technology industries and to improve the quality assurance of chemical measurements.

- High Performance Composites (10 positions and $1.0 million): Composites are attractive because of their high strength and stiffness, corrosion resistance, design and manufacturing flexibility, and effectiveness in conserving critical materials. They are an important area of world-wide competition in which the United States is no longer a clear leader. The program at NIST would focus on developing basic information needed to link the microstructure of material components to their performance characteristics.

- Lightwave Measurement Technology (Fiber Optics) (30 positions and $2.6 million): Lightwave technology is the basis for current and future communications and computer systems. Competition is intense in the international market for fiber optic components -- currently $2.5 billion per year and expected to reach $11 billion by the year 2000. This increase would add to the $2 million base program and enable NIST to provide more of the measurement capability that U.S. industry needs to develop and sell more competitive opto-electronic components in the world market.

- High Temperature Superconductors (8 positions and $700 thousand): International competition to develop and market superconductor products is unprecedented. This increase would enhance NIST's ability to conduct a research program as specified in the President's Superconductivity Initiative. The initiative called for NIST to develop measurement methods, standard reference materials, and supporting data as well as devices for measuring weak magnetic fields. In addition, it called for the establishment of a center of excellence at NIST for electronic applications. NIST has already made many contributions including implementing the first superconducting electronic device capable of operating at liquid nitrogen temperatures and fully characterized as a measurement device.

- Bioprocess Engineering (29 positions and $2.3 million): The United States currently leads the world in fundamental biochemical research and innovation in the laboratory, but is behind in the world competition to get the technology to the marketplace. The NIST program would focus on providing U.S. industry with the foundation of physical and chemical measurements needed to facilitate manufacture of products from microorganisms and animal and plant cells in commercial quantities at low cost. In particular, areas of proposed research include monitoring and control of bioreactors, commercial separation and purification of bioproducts, measuring thermophysical properties needed for design, and identifying and characterizing the relationship between molecular structure and conformation and chemical process behavior of biomolecules.

o Computer Security (41 positions and $3.5 million): The Computer Security Act of 1987 (P.L. 100-235) gives NIST the primary responsibility for developing standards and guidelines needed to secure sensitive, unclassified information in Federal computer systems. To continue to fulfill its assignments NIST needs an additional $3.5 million to provide 41 positions to conduct planned research on security architecture and standards for networks, methods, and standards for securing database systems, and uniform personal identification and authentication methods. These standards, guidelines, and methods will help assure that data are processed correctly and are available when needed and that only those authorized to use the data have access.

o Scientific Computing Upgrade (no positions and $3.1 million): These funds have been requested to upgrade the scientific computing facility used by both NIST and the National Oceanic and Atmospheric Administration, another Department of Commerce agency. The scientific staff of both NIST and NOAA/ERL need more powerful, flexible and useful computational tools to improve scientific productivity.

In addition to programmatic increases, adjustments to base budget of $809 thousand are requested. This amount includes an increase of $848 thousand for 1989 pay increases and related costs; $949 thousand for personnel benefit cost increases; and $795 thousand for inflationary increases in the costs of goods and services. It also reflects a decrease of $475 thousand resulting from anticipated management savings through A-76 studies and a transfer of $120 thousand to the Office of Space Commerce. In addition, Congress appropriated, on a one-time basis, $1,189 thousand in FY 1989. We are decreasing the budget by this amount in FY 1990.

Proposed programmatic decreases total 64 positions and $19.5 million. They are:

o Industrial Technology Grants (-8 positions and -$7.5 million): The FY 1989 appropriation for this program provided $7.5 million, which along with FY 1988 unobligated balances is sufficient to establish the first three NIST Manufacturing Technology Centers (MTC) and to operate them through FY 1990 at an average annualized level of $1.5 million each. The Secretary of Commerce has promised to review the MTC program along with other priorities in the FY 1991 budget process.

- o Center for Integrated Design, Non-Destructive Evaluation and Manufacturing (no positions and -$7.5 million): As mentioned earlier, the one-time FY 1989 appropriation will support the Iowa State University Center for a three-year period.
- o Fire and Building Safety Research (-49 positions and -$3.9 million): This would result in a $5 million program effort. The fire program that we propose would directly address safety work such as fire modeling and studies on the toxicity of combustion products. Similarly, the building technology program would focus on safety issues such as earthquake hazards, structural safety and engineering.

Other decreases include non-energy related inventions (-1 position and -$150 thousand), fire research on ignition of upholstery and general toxicity studies (-3 positions and

-$250 thousand) and study of alternative refrigerants (-3 positions and -$250 thousand). In each of these instances, specific accomplishments will be achieved in FY 1989.

A Broader View of the NIST Role

I would like to close with some observations about where NIST is and the philosophy that we are using in responding to our mission under the Technology Competitiveness Act. This past year has probably been one of the more eventful in our history as we made the transition from the National Bureau of Standards to the National Institute of Standards and Technology. Along with that name change, we saw the enhancement of our traditional measurement research and standards function to include a more general mandate to improve the competitiveness of U.S. industry. With this new mandate, we can aggressively respond to opportunities presented both by the needs of our society and by the constant flux of exciting developments in science and technology.

To my way of thinking, the NIST mission now has three major elements:

o measurement -- providing the scientific data and standards that our economy needs to compete in the world market;

- technology -- assisting U.S. industry to develop and apply emerging technologies to make world-class products; and
- technology transfer -- accelerating the application and wide deployment of new technologies developed at NIST and elsewhere, to enhance the competitiveness of U.S. industry. We have as available tools not only the traditional mechanisms, but also the new tools that the Technology Competitiveness Act has given us.

"Competitiveness" is becoming a cliche, but it has real meaning and real consequences. Competitiveness is the degree to which the U.S. can produce goods and services that satisfy customers in the international marketplace while simultaneously improving our real national income. Another phrase that is getting a lot of use these days is "world-class products." If the U.S. economy does not succeed in producing world-class products, our future will be one of decline. World-class products have the following characteristics:

- highest quality;
- advantageous life-cycle cost;
- modern features; and
- prompt availability in the marketplace.

Processes involved in the manufacture of world-class products must share these attributes. I would like to provide for you a few examples that illustrate the intersections between the expanded NIST mission and this definition of what U.S. industry desperately needs in order to market world-class products.

Quality

First I will discuss "quality." Motorola, a 1988 winner of the Malcolm Baldrige National Quality Award, recently did a survey of the quality of U.S. produced goods and services. The result was disquieting. The usual defect rate, or failure, in U.S. produced goods and services is about 6,000 per million actions. This is typical, for example, of the error rate you expect in your restaurant bill. The level of performance that Motorola and a very few other U.S. companies achieve is more like three defects per million actions, 2,000 times better. This is also the defect rate of much of Japanese industry. This is the level of quality expected of world-class products.

I believe that U.S. industry went through a phase in which it first denied the problem and then in some cases set out to solve the problem through advertising. Now many companies are recognizing that quality requires more -- more time, more discipline, more measurements and a more systematic approach.

One encouraging sign to me is the number of U.S. companies that set out to apply for the Malcolm Baldrige National Quality Award and concluded while studying the application that they were not yet ready to submit to the examination. The numerical information on the Malcolm Baldrige National Quality Award is intriguing -- 30,000 copies of the examination have been distributed since January, and we expect to distribute another 20,000 copies in the next few months. This is four times the rate in the first year of the Award; yet the number of completed applications has fallen from 66 to 40.

Through our discussions with industry, I conclude that the Malcolm Baldrige National Quality Award is meeting its intended purpose, serving both as an incentive and, more importantly, a source of education on quality for U.S. business. I am not immodest enough to claim that somehow the Quality Award is the unique cause of increased interest by U.S. industry. I think our competitors, their products, and their success in our market are the most significant factors. I am happy to say, however, that thousands of businesses are now actively using the examination document for self assessment, for initiating quality systems, for communications and comparisons, and as an adjunct to education and training particularly at the management level.

Measurement

Modern instrumentation and applications have approached the limitations of supporting national standards in a number of technical areas. A timely example, which combines developments in electronics with basic standards and industrial advances, comes in the area of modern voltage standards. To keep the U.S. competitive with other industrialized countries, NIST is exploiting the technology required to develop superconducting electronics. This program has been so successful that it has produced the world's most accurate voltage standards for voltages up to twelve volts, a voltage range widely used in electronic instrumentation.

The Hewlett-Packard company recently reported that they needed this standard to verify the performance of new type of meter which they are marketing. In the April 1989 issue of the Hewlett-Packard Journal, HP engineers showed that conventional techniques were inadequate and acknowledged the role played by this NIST standard in their product development. This example illustrates how U.S. industry often benefits directly in the rapid development and marketing of a new product even from NIST's most basic measurement research.

Measurement is also a key element in quality, and the opportunities and needs in measurement science have never been greater. Many of the critical technologies, such as high temperature superconductivity and semiconductor electronics, can only be exploited through the most exacting applications of measurement science. Many of the required measurement technologies involve, however, industrial and public sectors of enormous scope and size. This factor, the diversity and nature of the measurement technology, and the speed required to get new technologies to market, all work to ensure that no single firm or group of firms has sufficient incentive to produce, maintain, interrelate and support the measurement methods, reference data and reference materials underlying a critical industrial technolcgy.

Measurement science is critical to the quality of products produced, for example, by the $40 billion per year magnetic recording industry. The density of data storage on magnetic memory devices doubles roughly every two-and-a-half years, and now stands at over 10 million bits per square inch. Higher densities reduce both cost and space, and increase efficiency. To achieve further increases in data storage capacity and improvements in the performance of the read-write heads, and thus in the quality of products; industry must have the ability to visualize the actual size and shape of individual magnetic bits. A unique device that can do just that -- resolve magnetic microstructures as small as 10 billionths of a meter -- was developed at NIST three years ago. The device is called a SEMPA, for Scanning Electron Microscope with Polarization Analysis. SEMPA makes it possible for the first time to map -- at the atomic level -- the magnetic characteristics of the surface of materials, for example an entire floppy disk. This ability is the key to storing more and more information in less and less space.

The NIST device is so good that industries like Honeywell, Control Data, Westinghouse, and Digital Equipment regularly send their scientists to use the $3,000/day SEMPA facility. To quote a thank-you note recently received from Digital: "The SEMPA instrument in your laboratory with its versatile capabilities helped us to obtain magnetic images of several specimens which otherwise would not have been possible.... We believe that your group at the National Institute of Standards and Technology is an example of the highest level of knowledge and dedication which help our technology to stay ahead of the Japanese." In the past year, NIST researchers have assisted Perkin-Elmer to design a commercial version of the instrument; and its clones are now beginning to appear in other laboratories, Stanford and MIT to name but two. The key to advanced magnetic recording devices is the kind of quality in product development that the NIST SEMPA program has helped to ensure.

Industries dependent on chemical measurements also have a voracious appetite for advances in measurement science, which is often embodied in highly sophisticated automated instruments. Chemical measurement technology pervades a host of industries, from materials processing to medical diagnostics. There are 250 million chemical measurements made every day in the U.S., at an annual cost of $50 billion. Annual sales of automated analytical chemistry instruments currently amounts to $3 billion worldwide. NIST scientists work closely with not only U.S. industries that make chemical measurements on their products and process streams, but also U.S. manufacturers that produce the automated analytical chemistry instruments. As the result of a recent collaboration with Dionex Corp., a U.S. instrument manufacturer, a new generation of a widely-used instrument has been developed. This instrument, which is being jointly patented by NIST and Dionex, will revolutionize our ability for simultaneous multi-element chemical analysis. The forecasted sales for this chromatograph are up to $100 million over the next several years. Modern features of the kind incorporated in this new instrument are what will help keep the U.S. instrument industry competitive in the international marketplace.

Technology

Mr. Chairman, you may recall a DOC report released in 1987 that provided a status and futures assessment of seven of the most critical emerging technologies. These technologies will have an even greater impact on our economic well-being over the next several decades than they have in the past. It is interesting to consider the list of major emerging technologies given in that report: advanced materials, electronics, automation, biotechnology, computing, medical technology, and thin layer technology. A report as recent as 1987 did not include high temperature superconductors in its list, although its potential emergence was noted in the report. An oversight? No, the report was in fact quite timely. This is just an example of how quickly new technologies can develop, and you may be assured that more surprises are out there waiting for us. As Secretary Mosbacher reported earlier to you, this report is currently being reviewed and updated by the Department and NIST. He specifically charged us with proposing ways in which U.S. industry might be actively engaged to participate in the study.

About 40-45 percent of our directly funded research effort is devoted to the major emerging technologies identified in that DOC report. This didn't happen suddenly, of course; it has been a studied reaction to the increasing economic significance of these technologies. The NIST role in the service of emerging technologies is in the pre-competitive, laboratory proof-of-concept stage, when the technology is "generic." A generic technology is a non-product specific technology that is widely used by all firms in a particular industry.

A good example in the area of advanced material is advanced metals. Advanced metals can be formed from powders condensed into rapidly solidifying droplets by an atomizer, much like a jet from a can of spray paint condenses into droplets as it cools by expansion. Rapid solidification of metal powders from certain alloys results in metals with high strength-to-weight ratios, improved fracture toughness and fatigue resistance, unusual magnetic properties, and high heat, friction, wear, and corrosion resistance. These powders can also be processed into usable parts with nearly final shape by various methods that minimize waste and preserve these special properties. These powders are currently used to produce aerospace and other high-technology products such as jet engine turbine disks and fan blades that require materials with superior performance. The advantages that special features of these materials provide for improved quality and reduced life-cycle cost are also quite clear.

NIST programs in the intelligent processing of materials carry this technology one step further. Conventional production of such advanced materials is labor intensive and suffers from high rejection rates of finished product. Intelligent processing is a new computer-controlled approach to producing advanced polymer, ceramic, and metal alloy materials that are far superior to those in use today. The special properties of these advanced materials are the result of microstructures that are actually designed and built into them during processing, an achievement that can only be made by extremely fine process control and in situ measurement. The intelligent processing approach is based on the same concepts on which the NIST Advanced Manufacturing Research Facility is built. Continuous computerized monitoring during processing allows quality to be built in, rather than insured by post-production testing.

NIST has formed an industrial consortium involving three major manufacturers that produce or use metal powders. Its task is to develop the basic measurement tools essential for the intelligent system involved in the processing of these powders. Most of the cooperative research effort will be conducted at the NIST high-pressure, inert gas atomizer, in which atomized metal powders in the form of droplets cool at the rate of thousands of degrees per second. Some of this research will be industrial-proprietary in nature, a condition with which we are quite prepared to deal, and which clearly offers a special advantage to U.S. firms.

The NIST inert gas atomizer facility is based on a single large and unique apparatus. We have also been nurturing within the Institute a half-dozen small programs that are developing capabilities for finding, isolating, and manipulating individual atoms and groups of atoms on surfaces and in free space. We have seen "atomic wires" only a few atoms thick (a single human hair is a million atoms thick), a cluster of iron atoms that is perhaps no bigger than a single magnetic bit, and embryonic liquids and crystals formed from a handful of atoms. This is measurement science at the frontier -- what NIST scientists do best -- research that could ultimately have a major impact on several emerging technologies, including electronics and thin-layer technology. One possibility is semiconductor devices built up atom-by-atom instead of carved out of blocks of material, resulting perhaps in circuits thousands of times smaller and faster than anything available today.

Technology Transfer

The third element of our mission is an expanded effort in technology transfer. NIST has completed and will shortly be sending to Congress a report entitled "Domestic Technology Transfer Accomplishments, Trends, and Plans since 1986," which discusses our accomplishments under our traditional technology transfer programs. New assignments from the Technology Competitiveness Act will be collected in a new NIST operating unit, Technology Services. I have already mentioned the establishment of the Regional Manufacturing Technology Centers.

Technology transfer also means serving as a conduit, convener, and often stimulus to voluntary private-sector standards setting bodies, helping them to employ the latest technical advances with minimal impediments to manufacture and trade. NIST brings to the table not only technical expertise, but the "third party" objectivity and lack of proprietary interest essential to rapid deployment and acceptance of new advances in science and technology.

Some of the keys to promptness to market, particularly for expensive and intricate components that must work well with other products, are product standards, interface standards and other agreements and sets of requirements that aggregate a market. The simpler the requirements for a new product, the easier it is to connect with something already out there, the faster it can be designed and produced, and the greater the potential market for it. Where would we be without the product standard that defines screw threads, or the interface standards for voltage and frequency in electrical power systems? Modern examples come easily from all corners of the computing and computing-dependent industry.

PDES, which stands for Product Description Exchange Specification, is an example of how technology, in this case information technology related to the design, maintenance and use of data bases, is transferred to industry. PDES is intended to provide a standard format for a repository of measurement data about a product -- in digital form -- that will govern its entire production cycle. The data will describe such things as geometries (no more blueprints), fit, finish, tolerances, and complete instructions for automated manufacture. PDES is not the data itself, but the specification of the format for the data base. A buyer can then, for example, directly communicate his needs electronically to a supplier's manufacturing system. Quality is improved since product fit and tolerances are encoded into computerized specifications. Cost is reduced since process engineering is performed during the design phase, not after, and machine setup is automated. Build time and inventory costs can also be reduced because small lots can be more easily fabricated.

At a much more fundamental level, PDES is an emerging technology that deals with how to represent all the required knowledge about the product or process as data that can be stored, manipulated, and interpreted by machines without human manipulation. PDES is a very sophisticated technological enterprise that deals, in parallel, with the development of an emerging technology (knowledge representation) and an emerging standard (a data format). The very unusual parallel development of both a generic technology and a standard gives NIST a particularly unique role to play. I am proud to say that the NIST Automated Manufacturing Research Facility is being used as the national testbed for PDES, and that as a result NIST has led the effort to establish the PDES standard.

Technology transfer also means taking measurement techniques off the bench, out of the laboratory, and into the real world. The damage caused by last year's disastrous earthquake in Armenia was very real indeed. Our own H. S. Lew was among a select few invited by the Federal Emergency Management Agency to study the earthquake damage, and was recently honored by the Governor of Maryland for his participation. Using methods and models developed in our laboratories, he and others were able to study at first hand not only what fell down but what didn't. Combining laboratory results with these field observations will produce not only much better building codes and practices, but building designs and materials that will ensure quality without unacceptable sacrifice in construction cost. We are working to assure that substantial long term good can ultimately be derived from this terrible tragedy.

I could, time permitting, share with you many other examples of the network of links between NIST programs and the needs of the industrial and business world. Since time today will not permit the telling, perhaps someday soon, Mr. Chairman, you and other members of this Committee will permit us to do some showing. We are just up the road.

Thank you for the opportunity to appear before you today, Mr. Chairman. I shall be glad to answer any questions you, Mr. Danforth or the other members of the Committee may have.

The Chairman. I agree with your last conclusion. What is the difference between that and what the electronics industry is asking for in HDTV?

Mr. Kammer. Well, I think the analog in HDTV would be the open architecture that has been suggested by MIT, and that aspect of it I am just certain is the right answer. I believe that open architecture is the right way to go.

And once again, with that open architecture, like PDES does, is create the opportunity for a large number of technologies now to be tried out, and let the marketplace figure out which one. Create a format which everybody understands that they can design their products to so that the products will be compatible, but it does not tell people which product to get.

That open architecture that MIT has suggested would be just as accommodating of digital TV as it would HDTV, for instance, just to pick two products that may compete in the marketplace.

The Chairman. Thank you, Mr. Kammer. I appreciate your coming. We will ask your staff to use the clock.

And let me yield to Senator Gore.

Senate Gore. Thank you very much, Mr. Chairman.

And, Mr. Kammer, thank you for your testimony. I certainly enjoyed it.

You mentioned in your prepared statement and in your oral remarks the importance of fiberoptic cable technology. Some four years ago, with the assistance of our Chairman, I sponsored a bill which was ultimately signed by the President. Legislation creating a study on how we might establish a 3 to 10 billion bit per second research network in the United States. The study has been completed. One of the witnesses who will follow you to the table, Dr. Paul Huray, was a key figure in making it possible. And upon completion of the study, armed with its recommendations, I drafted and introduced legislation to begin putting this network into place, and to pursue the technological breakthroughs necessary to make it a reality.

The study found that the inherent capacity for a network of 3 billion bits per second is already there in redundancies installed by competitors in the long-distance telephone market. What are missing are the switches and the electronics, the last mile so to speak, these are impediments that we know how to solve, but work remains to be done.

Would you agree with the assertion that no single action by the Federal Government outside of dramatically improving our educational system, would do more to improve productivity and give us the chance to leapfrog the Japanese and other competitors than action to put in place a nationwide backbone network. It would facilitate real time communication at very high data volumes needed for supercomputers, and automated factories, and sophisticated control, statistical control technologies, et cetera? Would you agree with that assertion?

Mr. Kammer. I am not sure I know enough to make the comparative statement, but I will make a more specific statement. I am sure it is a major opportunity for us, and in the areas that I think I understand, which are more the technical areas, it is probably—it is the single most effective thing that I can think of personally to do.

John Lyons is the head of our National Engineering Laboratory, and he is responsible for what we call our lightwave technology, and I think he has also got some familiarity with this study. And I think he would like to talk a little bit more about it.

Dr. LYONS. I think it is a chance, Senator, to weave in the HDTV issue again and to make the point that Mr. Kammer made earlier about what is really interesting about HDTV. The kind of network you are talking about operating at gigabit rates is the kind of clock speed that you need in a supercomputer. It is the kind of clock speed that you need to process images in an HDTV television receiver.

One of the reasons that there is so much activity on the processors that are going to go into HDTV, and the reason DARPA is funding work on the processors, is that the current chips that process information—for example, the personal computers run at megahertz speeds, 8 to 10 to 20 megahertz, depending upon which one you have. But if you are going to really process the image in a receiver, you need to do that at what we call microwave frequencies, which are up in the gigabit range. So all of these things tend to come together.

The HDTV, the technology under HDTV is the same kind of technology, and now the fiber itself, as far as we can tell, has nearly unlimited capacity. We say terrahertz, which is a thousand times wider a highway, if you will, than the gigahertz range. It is at the visible wavelength frequencies. And we have been trying, along with others such as Bell Labs, to measure what the limit is, so that one of the new, most modern fibers, and we really are not sure, but I think of it as a giant pipe. And our problem is not the size of the pipe; it is the things that push things through it.

Senate GORE. Just to underscore this point, this is the first transmission technology where capacity improvements do not depend upon additions of more parallel cables. Improvements to capacity depend only on improvements to the electronics at either end of the cable and to the software that processes the information put through the cable, correct?

Dr. LYONS. You are absolutely right.

Senate GORE. Now, since we allowed competition in the long distance telephone industry, MCI, Sprint, and dozens more companies have laid fiberoptic cables all over this nation, and those cables have enormous redundant capacity. If we can speed up the introduction of new switches, new electronics, and new software we can make possible a nationwide network linking advanced computing facilities. It would also make possible the equivalent of interchanges along the way so that clusters of information-related businesses can grow up so that they are at the interchanges, giving state and local governments the incentives to build spur lines to smaller universities and smaller commercial centers.

In other words, we need to think about infrastructure in a new way. Instead of thinking of infrastructure in terms of highways, and bridges, and water lines, and sewer lines, we need to think of it in terms of information superhighways. And one thing that liberals and conservatives have been able to agree on where government's role is concerned is infrastructure. I am hopeful that later this year we will be able to move this initiative along.

In conclusion, since my time has run out, I agree with you on the relationship with HDTV. There are three measures in ascending order of controversy: the fiberoptic backbone network, which I think is the most important of all; an initiative to move on HDTV—and there is legislation pending to require a Department of Commerce comprehensive study on it, and there are other bills—and; lastly the most controversial proposal is one that Senator Gorton and I reintroduced to allow telephone companies to compete in the cable television industry. This last initative would, among other things, accelerate the introduction of fiber cables to the household, giving rise to the equivalent of work stations combined with HDTVs where people in their own homes could be linked up.

The initial legislation also would create a national digital library. I can foresee a day when a student at home could access a Library of Congress and all the information in the Library of Congress digitally, and participate in what they are calling co-laboratories with other researchers at distances geographically from that researcher or student.

But, again, that is what they call PANS, pretty advanced new stuff. And we have to get the basic cable in the ground first.

And my time has expired. Thank you, Mr. Chairman.

The **Chairman**. Senator McCain.

Senator **McCain**. Thank you, Mr. Chairman.

Mr. Kammer, from reading your statement here, you say any suggestion that the NIST enter the regulatory areas by recommending broadcast standards conflicts with your traditional role as neutral third party. Then am I to conclude from that statement that NIST would not be prepared to involve itself in any way until such time as the FCC laid out the parameters for which the HDTV would be implemented?

Mr. **Kammer**. I think we can be quite a bit more helpful than that without going to quite that level. The content of whatever standard, if you will, the FCC will issue, requirement, regulation, is going to be made up of a lot of technical specifications and a lot of forms of measurement that are not easily done. In some cases they are not done at all, and providing the tool measurement itself is what we are very good at. And we are very eager to do any characterization of the materials that may be associated with this.

The point that I am trying to make and it is a subtle point I admit, but we will tell you how to make the measurement, but we should not be telling society what level to set it at.

You know, we should not pick the number. We should not even recommend the number because at that point we become part of the regulatory process, and the relationship between NIST and industry now is a very collegial one. They are incredibly generous with us in sharing information and resources. When we become a regulator they begin to treat us like they treat the other regulators.

Senator **McCain**. I understand that. Give me an example of what you can do to aid in the development of HDTV as an American industry at this point in time and at the same time not conflict with what I think is a reasonable position that you do not want to enter the regulatory mode.

Mr. KAMMER. Sure. Dr. Lyons is on the right page right now, and if I may, I will ask him to respond.

Dr. LYONS. First, let me say what we are already doing. We started looking carefully at HDTV. We began to peel back the layers of technology, and it turns out that many of the emerging technologies that we have been talking to this committee about for some years are right smack in the middle of the HDTV issue. The first one, of course, is the fiber-optic business about which we have been coming up here, I guess, for four years in a row asking for enough money to do the whole job.

Senator McCAIN. Have you got that yet?

Dr. LYONS. No. There is a request in this budget for another piece. It is a $10 million problem for us, and we are working our way up toward about half of that with this budget.

Senator McCAIN. Would you be able to accelerate if you received your $10 million?

Dr. LYONS. Yes.

Senator McCAIN. Thank you.

The CHAIRMAN. That is a good answer, Doctor.

Dr. LYONS. I would defer to the acting director.

Senator McCAIN. Please proceed, Doctor.

Dr. LYONS. So much for light waves. Microwaves is another area. Some of these signals are likely to be broadcast from satellites in Japan. That is the plan. In this country I suspect that will be more limited to the remote areas.

But, as we were saying earlier, the devices that have to process the signals are going to begin to look like microwave-type devices. Then there are the magnetic media which Mr. Kammer discussed in some detail. We already work on data converters.

The signals always are analog at the two ends, but they will probably be all digital in between. That means you have to go back and forth from zeros and ones, digital to analog signals. All of these items we are working on. Those are some of the basic technologies.

We think that there will be measurements required to characterize, to specify, to purchase, to trade in, all of the equipment required for HDTV, whether it is studio equipment, the very expensive devices, or the more consumer-related products such as the receivers themselves.

There is always a noise measurement problem. There is cross talk between channels if it is going to be broadcast the way television signals are broadcast. You know, there is a problem in the cramming of the channels, and there is talk about using adjacent channels and putting some of the signal on one and some of the signal on the others.

There will be issues, then, of how much separation you need before you begin to get interference, and maybe I will stop there.

Mr. KAMMER. That is plenty.

Senator McCAIN. Well, maybe you should not if there is more that you have to tell the committee, Doctor.

The CHAIRMAN. Mr. Kammer, do not intimidate the witness.

Senator **McCain**. Let me do this, Mr. Kammer. I would like to have Dr. Lyons continue. But, at the same time, would you please provide the committee what you think is necessary or the areas that NIST can pursue, and I would also like to have a price tag put on that, and I do not believe you would be violating your guidelines by responding to such a request.

You are not requesting that money. You are providing the committee with the information requested as to what you need in order to pursue every avenue. I, like the Chairman, and I think most everyone else who is familiar with this issue, recognizes how crucial this is to America and to the future of this country, and I think we ought to at least know from you what areas that you can pursue to expedite this process.

Mr. **Kammer**. Of course we will.

Senator **McCain**. Thank you. But you do not want him to continue?

Mr. **Kammer**. He is free to. He was about out of gas.

The only other topical area that I can recall that I guess that he had not gotten to yet was the idea of a test bed, and there is probably going to be a need for a test bed as well. And that is a role we have pursued in many other areas. And the problem is you can write down in words the standards. But, until you have built it and tested it, you do not know if you really built it right, and so you would like place to test them so that everybody's will play together when they start building these things.

Senator **McCain**. Please provide us as complete an information as possible for the record, so that we would have it. I think it very, very important, and I would not want you to be constrained by viewing it as a budget request. We do not view it as a budget request.

[The following information was subsequently received for the record:]

At the present time, the National Institute of Standards and Technology (NIST) has no specific program to support U.S. industry's attempt to gain a share of the future high definition television (HDTV) market. The appropriate roles for the Federal government, for the Department of Commerce, and for NIST are under review by Secretary Mosbacher and comprehensive policy guidance is under development.

The areas of technology which will be required to support HDTV, however, are closely related to those which are important in other high technology segments of the economy including telecommunications, electronics, computers, and advanced manufacturing. Thus, NIST advances in these areas can be expected to have a positive impact on HDTV. Specific examples include:

> Electronics -- Proposed HDTV receivers will contain processors and semiconductor memories like those in personal computers. In addition, digital-to-analog and analog-to-digital converters will be needed to convert between analog and digital systems. At present, NIST has a program which provides selected measurement techniques that U.S. manufacturers need to produce semiconductor devices. Similarly, NIST supports the calibration of selected converters, primarily those used for precise measurements.
>
> Electro-optics -- Advanced displays may incorporate optical fibers, light emitting diodes or semiconductor lasers, or electro-optic switching components. NIST has a program to develop test techniques for a range of optical components for telecommunication networks.
>
> Data Networks -- For the foreseeable future, television transmission will, most likely, use a mixture of terrestrial broadcasting, satellite communication, fiber optic transmission, and cable distribution. NIST is assisting industry to develop the standards and test techniques for integrated services digital networks as well as for the components in microwave and fiber optic communication systems.
>
> Magnetic Media -- The recording for editing, and possibly for distribution, of HDTV programs will use magnetic media, both magnetic tape and magnetic disks. Both of these techniques are used today, but at much lower information densities than will be required in future systems. NIST is developing measurements for magnetic media as well as developing techniques to characterize the magnetic properties with geometric precision approaching the atomic level.

Senator McCAIN. Mr. Kammer, I am concerned about the deletion of the $3.9 million for fire and building safety research. If you would give us a rationale for why this reduction was made in the budget request.

Mr. KAMMER. Well, as I know the Senator knows, this is an issue of some history. I think this is the seventh year or the eighth year that this discussion has gone on. But the view of the administration has been that there is a balance between what ought to be done by state and local governments versus what ought to be done by the federal government and, therefore, argues that the balance is more appropriately fulfilled if we cut the program by about $4 million, leaving about a $5 million program in fire and building.

Senator McCAIN. My time is expired, Mr. Chairman.

Senator GORE. Would the Senator yield briefly on that point?

Senator McCAIN. Sure.

Senator GORE. If you have 12—if you have 12 stadium collapses and the engineers know in each case what structural elements led to that collapse, it ought to be in a central repository like the building safety. That is what you are charged with doing.

When the problem happened in Kansas City, it was a structural failure. A lot of times one of the terms of the legal settlement is secrecy on what caused the accident.

Well, you ought to have—I mean, we ought to learn from our mistakes, and that is what this building safety thing is all about.

Now, I want to underscore the Senator's concern there.

Senator McCAIN. Mr. Chairman, if I might reclaim my nonexistent time.

Mr. Kammer, there are aging facilities all over this country. The number of fires continue to go up in this country. The deaths as a result of fire continue to increase every year. I think you are aware of more of those statistics than I am. I just frankly do not understand the logic of saying that the state and local authorities can assume this kind of responsibility, and I am sure some tough decisions have been made but I think, Mr. Chairman, you ought to look seriously at restoring at least some of that funding, and I thank you.

The CHAIRMAN. Thank you.

Senator Gorton, you were here earlier.

Senator GORTON. Mr. Chairman, I want to second the views that have just been expressed by Senators McCain and Gore in that respect. I have no further questions on it, but I do think they made important points, and I would join with Senator McCain in his recommendations.

The CHAIRMAN. Very good. Senator Bryan.

Senator BRYAN. Thank you, Mr. Chairman.

A question to you, Dr. Lyons. If I am correctly informed, you have had occasion to be in Japan to personally observe government research projects, industry research projects, whatever their consortia arrangements might be.

I wanted to ask you if you could succinctly give me your personal observations on the differences between the Japanese approach which we hear and read so much about and the U.S. approach.

What are the basic philosophical differences between their approach and what we have been doing, at least up to this point?

Dr. LYONS. Well, I think they collectively approach problems probably more efficiently and more pragmatically than we do. You know that they have these various national projects which the MITI has generally sponsored, and we are coming to the opinion, I think, in this country that one of the reasons those national projects succeeded was not necessarily what was done within the national project but that each member company created an image program, a program that matched it, and the reason for that was the extraordinary competitiveness of Japanese industry.

Each person who joined the consortium decided that they were going to have a program back home that was very strong, and they were not going to let anybody get a jump on them, and so there was not just the national project, but it was all these matching programs back home.

A new phenomenon in Japan which we are also seeing in this country is the so-called industry led consortium with federal government participation, which we are beginning to talk about here. I think Sematech is the great prototype example of that.

Japan has been doing that for some years in a program called the key technology center where companies come together and create their own organizational units and make a proposal for federal funding. They take those things very seriously, and they dominate in many respect the national laboratory programs.

Senator BRYAN. With respect to key technology research, I am told there are about 40 different areas that have been funded as a result of this program. Can you tell us a little more about the makeup of the program. How much industry participation is there, how much government participation, and, just very generally in the time that we have available to me, of the guidelines? I am interested in the substance of how they actually put all this together in the funding component and the guidelines.

Dr. LYONS. Well, we can give you something for the record.

[The following information was subsequently received for the record:]

In 1987 John W. Lyons and George A. Sinnott of NIST (then NBS) made a study of the Japan Key Technology Center (KeyTech) and some of its programs. We are transmitting to the Committee the following items: [1]

(1) The report by Lyons and Sinnott of the 1987 trip. This describes discussions with the managers of the Key Technology Center and visits to some of the KeyTech program sites. Some of the background and philosophy behind KeyTech is included.

(2) An update prepared after a brief visit by Lyons to the KeyTech office in Tokyo in the spring of 1988.

(3) A listing of projects sponsored by KeyTech from 1985 through 1987. This breaks down the list of loans and investments by topics by year.

(4) The NSF report on Japan Key Technology Center call for 1988 programs.

(5) Brochures on KeyTech and on one of its more prominent sponsored projects, the Advanced Telecommunications Research Institute International (ATR).

Dr. LYONS. I would say very quickly that the companies first come together to define their needs and develop the plan. Again, that sounds like Sematech, but it is not the way the MITI programs used to be run.

The government may invest up to 70 percent, so the matching is less than 50–50. They have a finite life in the key tech program. I forget what the number is, but something like seven years, and then they are supposed to disband.

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[1] These items have been retained in the Committee files.

They have them in the advanced technology areas. When I last looked at them carefully and traveled around investigating them, they were largely in telecommunications, such as the fiber optics area.

Senator BRYAN. So, in effect, an industry group makes an application to the government and says we believe that this is a good project, worthy of federal participation. We are willing to come up with so many dollars. We need some help. Has that been successful for them in your view?

Dr. LYONS. Well, the key tech program is about four years old, so it is a little early to say. I would say based just upon the liveliness of the programs that they look as though they are going to be successful.

Senator BRYAN. At this point the preliminary indications are that.

Dr. LYONS. Yes.

Senator BRYAN. Is that not in effect choosing between winners and losers?

Dr. LYONS. Well, I suppose it is consensus I think in Japan——

Senator BRYAN. But is it. Maybe that is the question I ought to be asking. Does everybody that makes an application and seeks federal participation, do they all get funded?

Dr. LYONS. Oh, no. It is a competition, and the key tech center has an outside advisory board.

Senator BRYAN. So, in effect, government in responding to the request from the private sector, has to make a value judgment. This program is or is not worthy of funding. Or this program, frankly, ranks on a lower priority. Would I be correct in reaching that conclusion?

Dr. LYONS. That is the way it works, Senator.

Senator BRYAN. And you say that you think that it is a very promising approach?

Dr. LYONS. Yes, sir.

Senator BRYAN. I would yield my time back, Mr. Chairman.

The CHAIRMAN. That is the whole point, Dr. Lyons. We are trying to find out and get a feel from the committee what the competition is doing.

It is nice to sit back and let the private sector do everything. But government does have a role. We find agriculture is a winner, and so we subsidize it. We find other government endeavors, namely yours, of setting the standards, has been a winner.

We could have left that to private industry if we had wanted to. If you could elaborate on that I'd appreciate it. Now, I want to move on because we have another distinguished panel to follow you. But, I would like you to tell us about NIST oversight of our manufacturing or technology transfer centers. What is wrong with them, what is right with them, what suggestions that you would have to the committee to improve upon the endeavor.

Dr. JOHNSON. Thank you, Senator.

First of all, I would say that I think the three centers that we have started this past year seem to be doing extremely well. They are three centers that are very different in their character.

The center in Cleveland is located in a very high density industrial area where there are a very large number of small manufacturing firms that are doing the cutting, bending, shaping, and metal extruding of plastics business. Estimates there are more than 6,000 firms within about a half hour driving time of the center.

And so you heard earlier from Mr. Kammer that their strategy is to contact as many of those firms as they can, as quickly as they can, and determine which ones are most likely to be able to work with them, primarily with available off-the-shelf equipment and begin modernizing.

The situation is rather different at RPI. RPI is dealing with a very large state, the State of New York. That is very diverse. They are coupled to the New York State Extension Service as an outreach arm, and with the help of the New York State Extension Service they are looking for companies in the state of New York that are going to be capable of looking at more sophisticated automated manufacturing technology with a hope of adapting technology developed at the NIST automated manufacturing facility directly into some of those companies.

In South Carolina, as you know well, Senator Hollings, the very major strength that they have there is their technical school system, which I think is unique in the country, and we are working very closely with both the University of South Carolina and the technical school system.

We are dealing with a state that has a very different industrial character than the two northern and midwest states that we are dealing with in the other centers, and so the whole nature of the activity will be different.

I think from these three experiments, if you like, we are learning a great deal. One of the things we have instituted is a regular once a month meeting that rotates from one center to another. And we bring all the managers of the three centers together with staff from NIST, first at one center, and then we move to the next center so that they will share in what they learned.

We have also had a great deal of dialogue with people from all around the country in many different areas of manufacturing as to the applicability of this general kind of concept for a regional center to other areas of manufacturing other than cutting, bending, shaping of metal or making of individual small parts.

And it seems very clear to us at this stage that it is possible to adapt this kind of concept to a whole host of other kinds of manufacturing such as food processing. We have had dialogue with people, Senator Gorton, from Washington State. We have had some dialogue with people from Minnesota.

We have also had dialogue with several other states primarily in the South about the possibility of applying this technology to textiles and, of course, at Clemson University there is a center operating now that has many characteristics that are similar to this concept operating in textiles. So there are lots of other possibilities here.

Our sense is that if we were to call for proposals today, we would have, perhaps, three times as many proposals as we had in the first round. We had 36 last fall. Our guess is that we would have two to three times as many proposals, and our guess is that the range of applications would be really extremely interesting.

We would have applications ranging from electronics and parts assembly on one extreme to food processing on the other extreme. I think the concept is working fine. We are learning a lot.

One of the very fundamental things that we have learned is that each state does business differently and if we are to operate an infrastructure support program like this from the federal government, we have to be sensitive to those differences at the state level so that we are able to work with them effectively.

So, I think it is working very well, Senator. And I think by this fall when we get a report back from the second quarter, we will be able to give a pretty good analysis of the three centers and how they are functioning.

The CHAIRMAN. Very good. We can have a second round.

Senator GORE. I will do it briefly.

Back to building standards, foreign safety building standards just for a minute. You recommended a cut of 50 percent basically, is that right?

Mr. KAMMER. Yes, sir.

Senator GORE. You want to let go about half of your people?

Mr. KAMMER. Yes, sir.

Senator GORE. You have proposed that for the last eight years and the Congress has overturned it for the last eight years.

Mr. KAMMER. Yes, sir.

Senator GORE. So, it is fair to conclude that this is a kind of a budget strategy, right?

Mr. KAMMER. It is certainly not mine.

It has become. The issue, I think, has taken on a life that is almost separate from the substance of it.

Senator GORE. All right. We are going to do our best to restore that.

Now on superconductivity, do you agree with the assessment in the morning's newspapers that there may be a fundamental limitation on the usefulness of superconductivity because of the tendency of whatever it is, the flux fans to melt at higher——

Mr. KAMMER. That is certainly a reasonable argument to make right now, but I do not think that the jury is really in, and what is more, the application for the current density is certainly adequate for a lot of electronics applications which are what we would have expected to be the first application anyway.

Are we going to see a magnetic levitating train at one of the higher temperatures if this particular argument does not work out to our benefit, if Mother Nature is a little meaner than we originally had hoped, then maybe not.

But that still would leave us with lower temperature technologies, and they are very interesting.

Senator GORE. And still useful for computing.

Mr. KAMMER. Definitely still useful for computing.

Senator GORE. For supercomputers.

Mr. KAMMER. Yes.

Senator GORE. What does a supercomputer cost now, the top of the line, the Cray XMP?

Dr. LYONS. It is probably not the XMP anymore, but it is probably up to $20 million.

Senator GORE. Is it fair to predict that within five, six, seven, eight years the cost for the comparable supercomputing capacity will be down in the $300,000-$400,000 range?

Dr. LYONS. Sure.

Senator GORE. Most large and medium sized businesses in the United States, assuming they become aware of the tremendous productivity gains they can secure from them, will have them. Is that not a fair assumption?

Mr. KAMMER. Yeah. I have on my desk the power that the entire Bureau of Standards owned ten years ago.

Senator GORE. But the problem is we are at the fifth, sixth, or seventh generation of computing capacity, but we are only at the second generation of network capacity, correct? Our strength as a nation when we compete with other nations is that we are a coherent market, and we can throw our weight around in a good way in that sense. But in the information age, we are not yet able to do so because we are not linked together.

For example, even though global climate researchers all use supercomputers, they face. When they want to communicate with each other, these scientists have to download data onto a magnetic disk, and physically take that disk get on an airplane and fly to the other location. Only then can they take the disk and upload it and communicate with the other team. It is ridiculous.

We need to leapfrog the Japanese by linking our supercomputing and advanced computing capabilities and move beyond the second generation of network to the third, fourth, fifth, sixth generation network capacity. By the time our medium sized businesses have these $250,000-$300,000 supercomputers running the show, so that they are not isolated islands.

On HDTV a lot has been said. You said that we may see digital TV instead. We already have digital TV, do we not?

Mr. KAMMER. Sure.

Senator GORE. I mean the number of DRAMs in digital TVs without HDTV now threatens to approach the volume of DRAMs in computers.

Mr. KAMMER. The issue—whichever one of those, let us—whichever product is selected by the marketplace or whatever, the issue that IBM is arguing is basically the same. You are going to see the deployment of quite a few processors and memories in these devices. They are very intensive with respect to that.

So, their argument—that is why they are interested.

Senator GORE. I disagree with your orientation on HDTV, but it is a legitimate argument.

I just want to make one point in conclusion. I recently spent a good deal of time studying the decline in productivity in the United States and tried to learn more about it. It is an amazing story—that from 1945 until 1973 we had 1 to 2 percent annual increases in productivity and then from 1973 to the present time we have had zero, zero, minus 0.1 percent productivity gains for that entire period since 1973. Why?

The economists in studying the details tell us that the real turnabout came in the category called knowledge, and here we are in the midst of the greatest scientific revolution in the history of humankind and the greatest country in the world has a zero increase in useful knowledge where economic productivity is concerned.

What are the subcomponents? One is education. Our educational system has fallen into a pitiful state of disrepair.

Second is the availability of what is called for lack of a better word, "recipes" to translate basic research into useful technologies that our business and industries can use to improve the efficiency of the production process. That is the area the Japanese are the best in, and it is the area where we have fallen down.

And your responsibility, almost uniquely in the federal government is to turn that around. And you know from the Chairman's long-time focus on this particular area that you have the support of this committee, and I just want to encourage you to go all out to tell us what you need and we will do our best to get it for you.

The CHAIRMAN. Did you have any more, Dick?

Senator BRYAN. Just one question.

HDTV has been mentioned a good bit, not only this morning, but in previous hearings. What is the role that you are all playing in the review process which the Secretary earlier discussed with this committee and what do you think you ought to be doing?

Mr. KAMMER. Well, we have briefed many of our bosses at this point on a lot of the technical issues that are involved in this. And probably not too surprisingly one of the concepts that we have injected into the process is try to think about this in terms of imaging technology rather than just specifically HDTV.

And do not forget the implications of stringing cable up to people's houses, fiber-optic cable up to people's houses, which, as I said earlier I believe is a tremendously important opportunity for the United States.

And we have been writers of the analysis which at this point is submitted to the Secretary for his review, and he has not quite made a decision yet.

Senator BRYAN. Well, I am certainly not asking you to give us a preview of what the Secretary's opinion is. But I do need to get a sense of whether you are advocates for participation and involvement or whether are we are getting a lukewarm scientific evaluation which does not cause anybody's heartbeat to increase or are you in there saying look, we think this is important. America has got a stake in it. We think we as an agency have a role in it.

Just give us a little flavor as to whether we are seeing a little enthusiasm in terms of the advocacy or if you have a fundamental disagreement that we ought not to be exercised about it and ought to concentrate our priorities elsewhere.

Mr. KAMMER. This is a major opportunity for the United States in my personal opinion, and it is one that we ignored to our peril. My bosses deserve a chance to make their decisions. They have heard me and they have heard others, and eventually they will be able to make a decision.

Senator BRYAN. I guess what you are leaving this committee with this morning is that you feel that there is a major opportunity.

Mr. KAMMER. Yes.

Senator BRYAN. And I think that we can reasonably conclude from that, if I may, that you are advocates for an action role. Would that be a fair statement?

Mr. KAMMER. My personal philosophy is it is better to get in and do something than watch. You will learn a lot more doing something, even if it is not quite right, and then you can correct it.

Senator BRYAN. And you have shared that view forcefully and repeatedly, I would hope, whatever the outcome might be?

Mr. KAMMER. I have shared it politely and respectfully.

Senator BRYAN. Nobody could misinterpret where you are coming from.

Mr. KAMMER. No.

Senator BRYAN. That is fine. Thank you very much.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very, very much, Mr. Kammer. We appreciate you and Dr. Lyons and Dr. Johnson, your appearance and testimony here this morning.

[The following information was subsequently received for the record:]

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
[formerly National Bureau of Standards]
Gaithersburg, Maryland 20899
OFFICE OF THE DIRECTOR

[illegible] 1989

Ms. Fiona Branton
Minority Counsel
Committee on Commerce, Science
and Transportation
United States Senate
Washington, D. C. 20510

Dear Ms. Branton:

Enclosed are submissions to the record of the June 6, 1989, hearing on reauthorization of the Department of Commerce technology programs in response to questions asked by Senators Danforth and McCain.

If you need any additional information, please contact Esther Cassidy, Director of Congressional Affairs, at 975-3080.

Sincerely,

Raymond G. Kammer
Acting Director

Question 1:

What are the Department's plans for reorganization, if any, of the National Telecommunications and Information Administration (NTIA)? How will the Department's plan enhance the role of the NTIA in communications policymaking?

Answer:

The National Telecommunications and Information Administration (NTIA) is currently part of the Department's Technology Administration.

Secretary Mosbacher is still in the process of filling key positions in the Department, including the Under Secretary for Technology. A number of organizational matters involving various components of the Department will be reviewed as the process of filling these positions progresses.

Secretary Mosbacher has previously stated that he will do nothing that would in any way diminish NTIA's influence, compromise its integrity, or affect its ability to carry out the important responsibilities that have been assigned to it.

Question 2:

What is the National Institute of Standards and Technology (NIST) currently doing that will advance U.S. technology related to high definition television (HDTV)? What more can NIST do to help speed the development of a U.S.-based HDTV industry? What is the estimated cost of each HDTV-related effort?

Answer:

At the present time, the National Institute of Standards and Technology (NIST) has no specific program to support U.S. industry's attempt to gain a share of the future high definition television (HDTV) market. The appropriate roles for the Federal government, for the Department of Commerce, and for NIST are under review by Secretary Mosbacher and comprehensive policy guidance is under development.

The areas of technology which will be required to support HDTV, however, are closely related to those which are important in other high technology segments of the economy including telecommunications, electronics, computers, and advanced manufacturing. Thus, NIST advances in these areas can be expected to have a positive impact on HDTV. Specific examples include:

Electronics -- Proposed HDTV receivers will contain processors and semiconductor memories like those in personal computers. In addition, digital-to-analog and analog-to-digital converters will be needed to convert between analog and digital systems. At present, NIST has a program which provides selected measurement techniques that U.S. manufacturers need to produce semiconductor devices. Similarly, NIST supports the calibration of selected converters, primarily those used for precise measurements.

Electro-optics -- Advanced displays may incorporate optical fibers, light emitting diodes or semiconductor lasers, or electro-optic switching components. NIST has a program to develop test techniques for a range of optical components for telecommunication networks.

Data Networks -- For the foreseeable future, television transmission will, most likely, use a mixture of terrestrial broadcasting, satellite communication, fiber optic transmission, and cable distribution. NIST is assisting industry to develop the standards and test techniques for integrated services digital networks as well as for the components in microwave and fiber optic communication systems.

Magnetic Media -- The recording for editing, and possibly for distribution, of HDTV programs will use magnetic media, both magnetic tape and magnetic disks. Both of these techniques are used today, but at much lower information densities than will be required in future systems. NIST is developing measurements for magnetic media as well as developing techniques to characterize the magnetic properties with geometric precision approaching the atomic level.

The CHAIRMAN. The committee now will hear from the distinguished panel of Mr. John Fluke, Jr., of the National Conference of Standards Laboratories, Dr. Paul Huray, Vice President for Research at the University of South Carolina, Mr. Donald Weinert, the Executive Director of the National Society of Professional Engineers, Ms. Pat Hill Hubbard, Vice President of the Science and Technology Policy of the American Electronics Association, and Mr. Edward A. Miller, President of the National Center for Manufacturing Sciences.

Well, we will do it the Chinese way and go from right to left and start with you, Mr. Fluke.

STATEMENT OF JOHN FLUKE, JR., NATIONAL CONFERENCE OF STANDARDS LABORATORIES, BOULDER, CO

Mr. FLUKE. Thank you, Mr. Chairman. Good morning to you and to the members of your committee. It is indeed a pleasure and an honor to have the opportunity to address what I think is one of the more important and more enlightened committees of what is essentially the board of directors of the free world.

And I would also like to thank the trouble that both you and your staff have gone to to sift through the mountains of written testimony we have submitted. I thought that rather than reciting from that written testimony that I would attempt to back away and look more generally at the perspective about what message I was trying to convey in this testimony.

The CHAIRMAN. All the written testimony will be included in its entirety and as a panel we want the advantage of the opportunity to ask questions, so please summarize, and I would ask each of the particular witnesses to do that.

Mr. FLUKE. Thank you, Mr. Chairman. I guess I might start by first of all stating my particular affiliation here today while I am the Chairman of the John Fluke Manufacturing Company, an electronics manufacturer of a kind of capital equipment known as test and measurement equipment, the basic kind of capital equipment for use in the entire electronics industry around the world. And we do business around the world, particularly in Asia, where our arch competitors seem to be ensconced at the moment.

That I am actually here probably more on behalf of the National Conference of Standards Laboratories, and specifically the industrial segment of that professional organization.

I am here to talk mainly about the metrology function; that is to say the science of measurement and NIST's both traditional and current role in that field, there are others here who will talk about the new role that NIST has taken on that you expressed a great deal of interest in.

But I would like to make sure that we do not lose sight of the importance of that traditional role, what we used to call the National Bureau of Standards plays. And I would like to try to cast it in the perspective of the issue of competition that this nation faces.

Certainly when we look at the Japanese we characterize them as the finest most difficult competitor we face. They are so good that we sometimes accuse them of bending the rules and making up the rules as they go along and doing all sorts of things that we might characterize as unfair.

Senator **Gore**. And they sometimes do.

Mr. **Fluke**. And they sometimes do. We have done business in Japan since the sixties. We have never been a precisely targeted industry in the case of test and measurement instrumentation, but I can tell you that this is a very effective bunch of competitors, and we need to look not just at trying to keep them within the agreements they make with us with respect to trade, but we also need to look carefully at the offensive tactics that accompany, like Japan has. We need to understand what they are, and there is quite a range of them.

Certainly their cost of capital—they have one third or one fourth our cost of capital—is a factor. While we think we have about 20 percent-plus illiteracy rates in the basic functional area of literacy, we have illiteracy rates perhaps as high as 50 percent or worse in the fields of science and technology.

In the fields of geopolitical awareness and other areas that are crucial for American industry to be able to compete, that is another area that you mentioned that needs fixing in this country.

I could go on in other areas where the Japanese have a complete system of offensive tactics to assure themselves a major chunk of world market for manufactured goods.

One of the more obscure elements that they have that we used to have and have lost over the last 20 years is in the area of the science of measurement.

When you think about our loss of preeminence in machine tool business going back now 20 years or thereabouts, one of the things that is essential to building any sort of industrial capital equipment apparatus is basically that you be able to measure the things that it does, whether it be mechanical motion or the processing of electrical signals or what have you.

Over the last 20 years or thereabouts we have seen the R&D spending in real terms in private industry in the United States double. Over that same period of time we have seen NIST where what used to be the National Bureau of Standards expenditures in the same area remain essentially flat, no improvement in the level of funding of metrology research at all.

And yet it has become an increasingly competitive world, as you all know. It has become a world more demanding of lower levels of uncertainty in the operation of the industrial capital equipment that industry uses.

The Japanese have become very good at this. In our case, the various areas that have become weaker, too numerous for me to elaborate upon here.

I think you received a copy of a book which may not have a red cover—it may have a blue cover. It is from the National Conference of Standards Laboratories. It is title the Report by the National Measurement Requirements Committee.

This book goes through in excruciating detail all the areas where we find ourselves well shy of where we should be in the basic science of measurement.

The recent events in China should alert us to the fact that there is always the national security exposure, especially when our basic measurement system in the United States finds itself weak in a number of areas that American industry has made up for by going abroad to obtain acceptable levels of uncertainty in their primary standards.

The primary standards are what industry runs on in the final analysis. If you think of industry as an inverted pyramid, the National Bureau of Standards is right at the apex of that pyramid. We get levels of uncertainty that we need not from the United States anymore in too many cases.

This includes microwave and light wave measurements. It includes a number of mechanical standards areas where we find countries like Canada, Japan, England, Germany and in some cases the USSR where technology transfer permits, in mainland China as the best sources of an acceptable level of uncertainty in the periodic recalibration of the primary standards upon which industry runs in this country.

It is a national security issue we cannot afford, however obscure it might seem and however unglamorous it might seem.

By the same token, when we look at the traditional role that the NBS has played in technology transfer, they have been extremely successful at technology transfer to the private sector for essentially all of this century they have at any one time the better part of 1,000 scientists in residence from industry.

These people come to the centers in Gaithersburg, Maryland, in Boulder, Colorado, that the National Bureau of Standards operates to engage in basic and applied research to a point where they think they grasp a particular technology well enough that they return to their respective companies to commercialize that technology.

It has been a very successful program over the years, but over the last 20 years in particular and especially in this decade, as we have seen the continuous and unfortunate eroding of metrology research funding that we now find ourselves in I think a very desperate and dangerous state.

I do not know how China will turn out. I am personally somewhat discouraged by the developments that we have seen there. They could well eradicate almost a decade of very good progress in that country.

I do know that we are not going to be able to get because we do business in China regularly, that we are not going to be able to get our standards in and out of those Chinese metrology laboratories that we formally have come to rely upon.

I could go on and on, but I think the other panel members have some important comments to make as well, and so I would defer my time on to them. Thank you very much.

[The statement follows:]

STATEMENT OF
MR. JOHN M. FLUKE, JR.
CHAIRMAN
JOHN FLUKE MANUFACTURING COMPANY, INC.

ON BEHALF OF
THE NATIONAL CONFERENCE OF STANDARDS LABORATORIES

BEFORE THE
COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION
UNITED STATES SENATE

JUNE 6, 1989

Mr. Chairman and Members of the Committee, thank you for your invitation to testify on the proposed 1990 budget for the National Institute of Standards and Technology. I appear before you today representing the domestic industrial segment of the **National Conference of Standards Laboratories (NCSL)**. In addition to actively supporting the activities of the **NCSL**, I am Chairman of the Board of **John Fluke Manufacturing Company, Inc.**

Through my 23 year association with **John Fluke Manufacturing Co.**, which was founded by my father over 40 years ago, I have come to appreciate the importance of the National Institute of Standards and Technology (NIST), particularly its role in measurement and standards activities to American business. My contact with the **NCSL** over the years has served to strengthen this appreciation.

I should like to discuss several important aspects of NIST's missions which are of great importance to the **NCSL** and to **the John Fluke Manufacturing Co.** today and will provide special focus on three: competitiveness, technology transfer, and metrology and standards. As I will show, it is in these three areas that the future well-being of the American manufacturing industry (note that I do not limit this to any one sector) will depend. These three topics are interrelated and interdependent, each requiring and supporting the others.

FUNDING NIST FOR TECHNOLOGY TRANSFER AND COMPETITIVENESS

Last year, the Congress responded to the perceived need for fostering successful commercialization of newly-developed leading edge technologies. The Trade Act added significantly to the core metrology missions of the Institute with responsibilities for improving quality, modernizing manufacturing processes, and facilitating the transfer and commercialization of new technology. We strongly supported this action.

Unfortunately, the funding proposed by the Administration for the Institute in the 1990 budget barely keeps pace with inflation, with no funds being provided for the new technology transfer functions let alone providing funds to correct a shortfall in measurement standards research and development which has grown over the years. Both the Institute's traditional measurement and quality assurance roles and its new manufacturing and technology transfer functions must be adequately funded if the new NIST is to have the desired effect of helping American industry compete in the global marketplace.

The importance of this as we approach 1992 and the formation of the new European Economic Community (E. C. 92) cannot be overemphasized. Within the new Community trade barriers will be all but eliminated; non-tarriff barriers to trade between the Community and the U. S. must be carefully guarded against. One such non-tarriff barrier could be related to standards and measurement. Although we see no indication that E. C. 92 will foster such actions, we do see a significant cost advantage to members of the Community in this regard compared to outsiders. Our need is to have sufficient and recognized standards and dissemination techniques to compete and not depend on our new trading partner - the European Economic Community.

METROLOGY - QUALITY - COMPETITIVENESS

The lowest priced product is not necessarily the most competitive product. Customers' needs and wants are many and varied but universally they include **quality products, delivered on time, and meeting their special needs**; for this, customers are willing to pay. Evidence for this fact is all around us but we need only look at all the Japanese automobiles and consumer electronics in our country to confirm it.

There is an irrevocable link between product quality and measurement which has been largely overlooked in this country. The key to the testing required by a modern, efficient and effective quality control program is sound and proper measurement, based on a program of standardization to assure the accuracy of measurements. Measurement standardization is achieved most efficiently through an effective, well understood and properly functioning national measurement system, headed by a competent and committed national standards laboratory.

As is the practice in most industrialized nations, we believe the development and delivery of measurement and standardizing services are rightly the province of the federal government. Development of new and improved measurement services should be funded by congressional appropriations as a public good. Equally strongly, we believe that the cost of using the services should be borne by the user for a cost-based fee. Last year, the Congress permitted the Institute to assess an 8% surcharge on calibration service fees to be ramped at 8% a year until the surcharge reaches 40% of the current fee. The NCSL domestic industrial membership has two concerns about the imposition of the surcharge: First, the steepness of the ramping without any known limitations bothers us somewhat; the congressionally-mandated monitoring of demand impact does reduce our concern, but the analysis of demand needs to be rigorous and able to determine sector weaknesses. Secondly, we have a concern about the uses to which the surcharge windfall will be put. We have reviewed the plans and methods employed in administering the funds and believe that, so far, NIST is on the right track.

Competence and commitment, mentioned above in respect to the characteristics of the national standards laboratory, are needed not only for establishing and maintaining the basic standards upon which measurement accuracy depends, but also for developing the devices and equipment for scaling to multiples and fractions of those standards. Also needed is an effective and efficient apparatus to make the benefits of standardization available to industry. Competence of the level required will not be achieved or even maintained with no growth budgets and declining personnel levels within NIST. The infrastructure to provide the dissemination of standards to industry is in place through the national measurement system headed by NIST; what is needed is the revitalization of NIST, starting with adequate funding.

WE ARE LOSING THE INTERNATIONAL MEASUREMENTS RACE

At the end of World War II, the then-NBS was the undisputed leader of the world metrology community. At some point in the 1960's, however, NBS appears to have lost the sense of mission which had enabled it to achieve that position of leadership. Budget problems and, to some extent, management decisions began to erode the base of monetary and other resources which had been dedicated to advancement of its primary mission, the establishment and maintenance of an adequate and accessible system of measurement standards. Prior to the 1960's, the NBS led technology with measurement capabilities that far exceeded most industrial needs. These excess capabilities were in the bank, so to speak, waiting to be withdrawn by industry. And, from time to time industry would make withdrawals from the account. But beginning in the 1960's, industry's capabilities began improving at a faster rate than those of the NBS. Before long, requests for measurement services - withdrawals from the account - began to be met with a response of insufficient account balance. The NBS was no longer able to meet the needs of the nation. Several countries, including Germany, England, France, the USSR, Japan, Australia, and Canada now match NIST capabilities in the basic measurement areas. For the most part, they are using technologies developed by NIST in its golden period.

About twenty years ago, the then NBS made a change in the value of the US volt; the change was very small, in the low millionths of a volt. At the time, industry reaction was universal: So what? The change was too small to worry about. Next year, NIST is planning another change in the volt of about the same magnitude. Today, industry's reaction is much different. Today industry is concerned and a major effort is underway to minimize the impact of the change. What's different? For starters, today industry can and does routinely make measurements in the range of the change being considered. In other words, industry's capability has improved to the point that it rivals that of the state of the art of not only NIST but the world.

Of much more concern, though, is that the countries noted and China now far surpass NIST capabilities in a number of measurement areas. At the same time, and also of much concern, is the fact that **the U. S. has no standards and measurement capability in several measurement areas important to U. S. industry.** Not only is the U. S. in danger of becoming a second class citizen in world measurements and standards, but we also have lost our strong capability in modeling and communicating the measurement process. Industry is currently struggling with attempts to implement techniques for computing and reporting measurement uncertainties which were published by NIST 20 to 25 years ago - a struggle which should have been made unnecessary by proper guidance by NIST professionals in these disciplines. And now

NIST's effectiveness is being further reduced by the retirement of a substantial number of senior metrology scientists.

The **NCSL's National Measurement Requirements Committee** conducts studies to determine current and emerging needs for measurement support from NIST and NIST's ability to meet those needs. In 1982, the study showed 97 deficiencies (areas where NIST's capability did not meet industry's needs). The 1988 report, published in January 1989, identifies some 154 deficiencies and projects 250 deficiencies by 1995.

The report indicated priorities for the first four major categories as follows: **Flow measurement** (previously mentioned as contributing to excessive costs of a quarter billion dollars a year); **Atmospheric measurement** (necessary in efficiency in fuel use in aircraft and altitude separation between aircraft - a safety issue); **International standard coordination** (noted as necessary not only in commerce and in combating non-tariff barriers to trade but also in being able in the US to respond quickly and effectively to proposed changes in international standards); and **Microwave measurement** (noted in the report and in previous hearings before this Committee as of critical importance to the Nation for both defense and commercial telecommunications). All of the 154 items noted in the report are important enough to concern its authors and us; we think they are important enough to concern you. The report makes clear that there are shortfalls in all major areas of NIST's responsibilities which affect all industries and all businesses, large and small.

Recent events in the scientific arena serve to highlight the importance of careful measurement and experimentation. Not being a research physicist I am not competent to determine whether the claims for a table-top cold fusion breakthrough has actually occurred or not. However, the differences between and among a number of knowledgeable scientists concerning what did occur clearly shows that careful experimentation must be coupled with sound and accurate measurement techniques in order to place any credence on the results.

The issue of restoring the Institute to its historic position is not an academic one nor is it merely a matter of national pride; we are in a race that will determine the ability of the U. S. to compete on an equal basis with other industrialized nations. The outcome may well determine whether we continue into the 21st century as a major economic force or not.

NEEDED: A LONG-TERM COMMITMENT TO NIST

The organizations I represent perceive a deterioration in NIST capabilities - particularly in the primary mission area: research, development, and dissemination of adequately precise and accurate measurements, measurement standards, and methods of measurement. This has occurred over a number of years, at least since the mid to late 1960's; its correction will take some time, although we hope not nearly as long. I believe that fundamental changes in funding direction are necessary to restore U. S. competitiveness in metrology and to assure rapid and effective transfer of technology to American industry. Reductions in or even holding the line on budgets for this agency is clearly not the answer in our attempts to restore the Institute to the level of performance and capability demanded by today's scientific, technical and economic conditions. A substantial increase in NIST's metrology budget is necessary to combat years of neglect, during which time many have taken the Institute for granted, believing that they would find a way. The increase we propose here is over and above any other increase to accommodate NIST's new charter.

NIST's success in the future is largely dependent upon what we are able to accomplish here, today. The gap identified by the NCSL's Committee noted previously must be closed and it must be closed in a reasonable timeframe, no more that five years. In prior years the Administration has sent up proposals that included initiatives for process and quality control for physical measurements as well as chemical measurements. Some of these were authorized and even funded. These "on again, off again" approaches to the budget of the National Institute of Standards and Technology are not meeting the nation's needs. It is time for this Committee to seek alternative approaches to solving this very difficult problem and to initiate the steps to return the Institute to its proper place among national standardizing laboratories.

The Senate Committee's leadership is urgently needed to halt the deterioration, to provide a course which reverses the recent trend, and to provide a long-term plan including adequate funding and oversight that will assure that proper planning and execution of programs to achieve the goals.

The Administration's proposed budget falls far short of what is needed. We applaud what it does propose and among the initiatives - all of which are worthy and necessary - we would single out for specific mention two. Our membership strongly supports the process and quality assurance initiative for chemical measurements. This initiative was proposed last year and, we think, authorized. However, it was never funded. We also support strongly the initiative for lightwave measurement technology, a rapidly developing new technology of great importance to the nation. We urge the Committee to approve all of the initiatives proposed in this budget.

However, the proposal does not go far enough, either in requesting funds for implementing the Trade Act mandates or in requesting sufficient funding to begin to correct prior year shortfalls. We are not expert in the intricacies of the Trade Act and, consequently, do not feel competent to assess what the funding needs are to implement it. We are certain the number is not trivial - probably in the range of 20 to 30 millions of dollars per year - but it is necessary if we are going to keep the promises made last year.

Concerning prior year shortfalls in the measurement standard development and delivery arena, however, we do have a general feel for the costs involved. Based on estimates made several years ago to correct a fewer number of deficiencies, it is clear to us that in this specific category alone an investment of a least ten million dollars and probably nearer fifteen million dollars a year for a minimum of five years will be necessary to get us back to where we should be. In measurement standards and delivery services this investment would restore the "level field" in international markets each of us sees as absolutely necessary.

As a complement to Congressional leadership, NIST must also be provided with strong internal leadership both within the Institute and at the Department of Commerce. I ask the Committee to join with us in urging the Administration to select and to expeditiously nominate individuals for the positions of Undersecretary for Technology and of Director of NIST who are knowledgeable and experienced and who will provide the leadership necessary in these critical time. The individuals must understand industry's needs and the Institute's role in meeting those needs and be willing to aggressively pursue their Agency's missions, both new and continuing.

NEW INITIATIVES

We strongly disagree with the Administration's decision not to request funds for the new technology transfer programs: the regional centers for the transfer of manufacturing technology; the industrial extension services program; the advanced technology program; and the clearinghouse for state technology programs. There is no question that the federal government has an important role to play in helping industry to improve the applications of civilian technology, and thus to aid in our remaining competitive in world markets. The new missions envisioned in the Trade Act of last year, the new initiatives in the Administration's budget proposal, and the necessary programs to restore NIST's capabilities in the metrology and standards area are all critical in this quest to improve our international competitiveness.

To improve anything including technology there has to be an investment, an investment of funds, of time and of dedication. Mr. Chairman, the Administration's budget proposal is inadequate in respect to the investment that will be required to correct years of neglect of its core mission. It is inadequate to implement the new missions in technology transfer, thus failing to make the investment necessary to prepare this nation for the future.

We have reviewed data and charts which track the budget of NIST over time and against a couple of pertinent bases. One such comparison shows NIST's Congressional appropriations vs. industry funded research and development. In constant dollars, industry funded R&D doubled from 1973 to 1987; NIST appropriations were at best flat and perhaps downward sloping very slightly over the same period.

Mr. Chairman, the National Conference of Standards Laboratories is a strong supporter of the National Institute of Standards and Technology. Most of our support and interest is in what we refer to as the core mission of NIST: research and development of measurement standards and techniques and delivery of those developments to industry, commerce and academe through calibration services and standard reference materials. But we firmly support the other and newer missions of NIST as well; in particular, the technology transfer mission envisioned in the Trade Act is one we see as an investment in the future. The support technology - developed by or through NIST - must be transferred to industry expeditiously and effectively.

CONCLUSION

In summation, this budget proposal is woefully lacking in most of the core areas of NIST's responsibilities and is manifestly inadequate in respect to eliminating shortcomings of prior years that are still present today. Finally, we observe that the vision of an NBS with a wider role in advancing technology in the U. S. through the technology transfer centers - that is, a **NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY** cannot be realized with budgets which are continually reduced or not even asked for.

The CHAIRMAN. Thank you. Dr. Huray.

STATEMENT OF DR. PAUL HURAY, SENIOR VICE PRESIDENT FOR RESEARCH, UNIVERSITY OF SOUTH CAROLINA

Dr. HURAY. Thank you, Senator Hollings. It is a pleasure to appear before you today. I am going to merely summarize the comments that I have in my written testimony, and I am going to leave out those portions that Ray Kammer, John Lyons, and Don Johnson have described.

I would like to begin with a personal observation. I was a physicist at the Oak Ridge National Laboratory for most of my career, and I had graduate students working there, many of whom fortunately spoke Japanese and Chinese, and we found that we were entertaining a lot of visitors from corporations at this great laboratory, many of whom spoke Japanese and Chinese.

Later I learned from our technology transfer office that there were more visitors from Japanese corporations over a ten-year period than from U.S. corporations. That did not surprise me from my personal experience, but it is a sad commentary, I am afraid, about a great resource for our country.

Senator GORE. Could I interrupt with a comment?

Dr. Huray, when you joined me for the introduction of the legislation on the nationwide fiber-optic network two weeks ago, I noted that in the room there were more Japanese reporters than there were U.S. reporters, and I just wanted to interject that for the record. Excuse me for interrupting.

Dr. HURAY. As a matter of fact, when we responded to your legislation in the FCCSET committee, we did not see any evidence of the report appearing in U.S. newspapers, but it was on the front page of the Tokyo Times.

A second irony that occurred during that period that I was working at Oak Ridge was that engineering colleagues of mine were helping the Y-12 facilities (in defense activities) machine mirrors to precisions of a millionth of an inch. At the same time, our corporations in America were losing competitions with Japanese counterparts because they could not manufacture parts reliably to a ten thousandth of an inch.

We had the technologies in the laboratories, and we were not giving it to our own corporations.

I think the NIST manufacturing technology centers provide a way to overcome this problem. Of course, many of the large firms in America do come to our national laboratories and to NIST to receive that technology. But there are over 100,000 small corporations in America with 50 employees or less who are not taking advantage of that technology, I cannot imagine Ray Kammer trying to provide that information to those 100,000 corporations. Their representatives alone would fill JFK Stadium. It cannot be done within previous resources.

I see three kinds of problems that I have tried to identify in my written testimony that have led to this situation. There are, of course, many more, but one is that NIST and the national laboratories just do not have the resources to work with all those corporations. I do not mean just money, but people that cannot handle the volume. Secondly, there is a kind of a yin/yang effect in U.S. corporations. They are very independent, they are very entrepreneurial, they are very innovative, and that leads to the not-invented-here principle—so while individuality is a strength for us, it leads to a weakness that corporations tend not to approach the national laboratories for assistance. And then, finally, the Japanese have the coordinated structure that Mr. Bryan spoke of.

I see the NIST centers as addressing all three of those problems; those weaknesses. By having universities work with NIST, you essentially obtain an army of people providing technology transfer, and these centers are primarily designed to provide a delivery system of the NIST technology to small industry.

In our case in South Carolina, which I of course know the best, we have 26 separate institutions working together to provide the vehicle for technology transfer from NIST. Our engineers from the University of South Carolina are working with NIST engineers to find the correct kind of technology for metal fabricating businesses. We then work with the technical colleges in the state to provide a transfer of the NIST technology. The technical college instructors have been working with the small metal fabrication corporations over the last 25 years. Senator Hollings, who was then governor, helped create those technical colleges. They have trained over 18,000 employees in the 1,200 metal fabrication corporations that exist in South Carolina alone. The corporate employees are familiar with the technical college instructors, and there is a familar culture (a trust) that has been built up over the years.

The pattern for transferring the NIST technology is in place. All we have to do now is provide the vehicle for it, and these centers are providing that vehicle. Of course, it is early in the game, and it is not clear yet whether it will be a complete success.

The AMRF, however, has in its facilities such things as numerically controlled milling machines, lathes, automated materials handling equipment and industrial robots to tend to those machines. In other words, it is kind of a factory of the future, and the idea is to bring that technology to those corporations where it is appropriate.

Small corporations, of course, generally do not have access to this kind of technology. Big corporations like General Motors do have their own factories of the future. Small corporations have different problems. We find that it is a big decision to them to buy computer-controlled machines. They have to buy them one at a time, and they often do it in series. A $100,000 decision to them is a life-threatening decision in many cases. And when they get through with the purchase of a series of these purchases, they have to make sure that the system is integrated, the machines work together and they produce parts without a lot of costly reprogramming.

Finally, the small corporations need to provide parts in small batches, in ways that allow them to keep track of the process as it is going on. The traditional path is to make a part, check it to see if it meets tolerances and if it does not, rework it. The small corportions need to have the technology to measure those parts while they are in the process rather than reworking or scrapping the parts. We estimate about a third of American manufacturing is used up in reworking parts that did not meet tolerances.

I referred in my written comments to a number of advances that have been made in the centers so far, and I would like to cover a few of those.

These centers started only in January, and so there has been a limited experience. So far, we have been educating the educators; that is, the people that are going to transfer this technology have to have a coherent story.

We have been preparing demonstrations for the corporations, and we have been contacting the corporations. In fact, we have been overwhelmed by the response. Corporations are eager to have the NIST technology, and we are having trouble handling the volume.

We have been preparing facilities and equipment and we have been developing program staff. Finally, we want to be able to determine whether or not we have succeeded in a few years. So, we are trying to find a survey instrument that says, "here were the changes that were made as a result of this program."

Soon, we believe within the next year, we will begin to expand and replicate the centers where we have success, not just in South Carolina for our case, but into other states in the southeastern United States.

I think I will terminate my verbal comments at this point in the interest of my fellow panelists

[The statement follows:]

Proposed Testimony
of
Paul G. Huray
Senior Vice President for Research
University of South Carolina

Mr. Chairman, my name is Dr. Paul G. Huray. I am the Senior Vice President for Research at The University of South Carolina. It is a pleasure, Mr. Chairman and members of the committee, to appear before you today to discuss the Manufacturing Technology Centers of the National Institute of Standards and Technology (NIST). Today, I want to:

- o Give a few background anecdotes and statistics which relate to the centers,
- o Describe the three existing centers and the technologies they provide,
- o Focus on the current status of the centers, and
- o Project how the programs may contribute to the industrial base and economic development of their respective regions in the U.S.

BACKGROUND

I do not need to convince this body of the importance of recovering our edge in manufacturing technologies, but I would like to relate several experiences which show why the NIST centers are such a good idea. I have also included several statistical trends which support this argument.

For most of my career, I have been a physicist at the Oak Ridge National Laboratory. Over that period I was aware of the disproportionate number of foreign corporate representatives who visited my laboratory. Fortunately several of my graduate students spoke Japanese or Chinese and they easily conversed with the visitors. I was therefore not surprised to learn from our technology transfer office, that over the 10 year period from 1975 to 1985, there were more corporate visitors to ORNL from Japan than from the USA. An irony of this situation was that some of my engineering colleagues were helping the Oak Ridge Y-12 operations to machine mirrors to a precision of 0.000001", yet American machine shops were losing business to their Japanese competitors because they could not reliably machine objects to precisions of 0.0001". The taxpayers of America had paid for the highest machining capability known to man in our federal laboratories, but we were not transferring that technology to our own machine shops.

I believe that three factors contribute to this situation:

- The National Laboratories simply do not have the resources to work with enough small-to medium-sized businesses in America and thereby cannot transfer the technology that they posses to them, and
- The corporate culture of America is so steeped in the "not-invented-here" principle and a spirit of independence that they do not actively seek the technology.
- The Japanese have developed a coordinated government/industry strategy to improve their manufacturing competitiveness.

As a consequence of these tendencies and a number of associated effects, manufacturing capacity of high technology products in world markets has suffered significant losses. Two of the more familiar trends are shown in the table below and in Figure 1 (produced by the U.S. Department of Commerce and the National Science Foundation respectively).

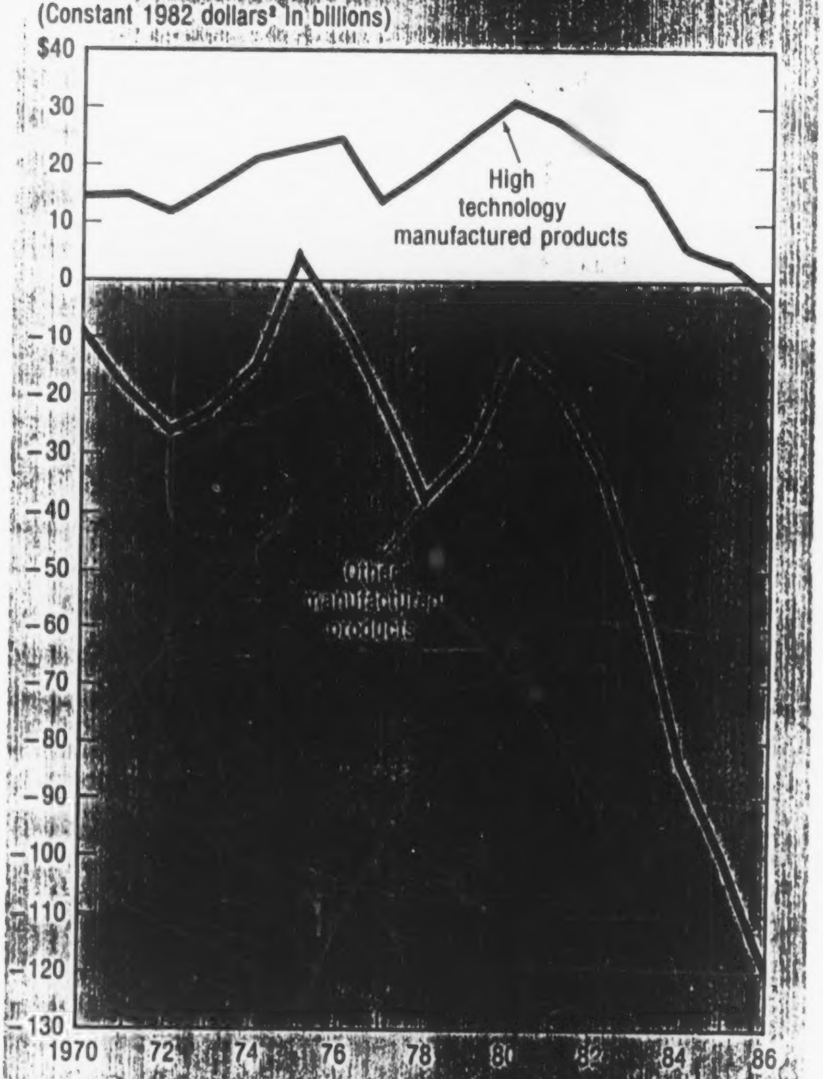
U.S. Share of Domestic Technology Markets (Which it Pioneered)

Technology	U.S. companies' share (%)				1987 U.S. Market
	1970	1975	1980	1987	
Phonographs	90	40	30	1	$ 630 M
B&W Television	65	30	15	2	$ 175 M
Color Television	90	80	60	10	$ 5.1 B
VCRs	10	10	1	1	$ 2.9 B
Telephone Sets	99	95	88	25	$ 2.0 B
Machining Tool Centers	100	97	79	35	$ 485 M
Semiconductors	89	71	65	64	$ 19 B

These special cases contribute to the overall imbalance of trade figures which is so familiar to all of us. Figure 1 shows the integrated summaries for manufactured products in high technology and other areas as a function of time since 1970.

Figure 1.

U.S. trade balance¹ in high-technology and other manufactured product groups



¹Exports less imports [illegible]

²GNP implicit price deflators used to convert current dollars [illegible]

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Fortunately, several recent congressional and executive branch initiatives have addressed these weaknesses:

- President Reagan issued Executive Order 12591 which instructed Executive departments and agencies to "encourage and facilitate collaboration among Federal laboratories, State and local governments, universities and the private sector, particularly small business, in order to assist in the transfer of technology to the marketplace." This E.O. included the Technology Share and Exchange programs and the creation of government/ university/ industry Science and Technology Centers.
- The Congress addressed these weaknesses in the Technology Transfer Act of 1986 and in the Trade bill of 1988. The NIST Manufacturing Technology Transfer Centers, working with university and small-to medium-sized private corporations, were one of the consequences of that legislation.

The university participation in these activities is not a surprise when you consider that foreign graduate students are pouring across our borders at ever increasing rates, and that by any measure (publications, references, or patents,..), U.S. graduate science is the best in the world (for example there have been more Nobel prizes won by professors at the University of California at Berkeley than by the entire Soviet Union). Of course, foreign countries understand the importance of a science and engineering education to their economic futures and they know where to obtain the best education and research in the world. These countries are therefore sending their researchers not only to our Federal Laboratories but to our universities. As a consequence, the fraction of foreign students awarded the Ph.D. degree in engineering has exceeded 50% every year since 1981, and there are reasons to believe that their participation in U.S. science and engineering disciplines will continue to increase in the future.

The recognized ability of University professors and the familiarity of technical college instructors to interact with the workers of American industry was recognized by the NIST as a mechanism to distribute technology to U.S. manufacturers from the Automated Manufacturing Research Facility (AMRF). Thus, the Manufacturing Technology Transfer Center program has incorporated a unique approach to addressing the needs of small-to medium-sized industry in the U.S. which was not being met by any other program. An expected secondary result is that feedback from the industry will provide NIST with "real-world" evaluations of which technology is appropriate for struggling firms.

The programs of the AMRF which are initially available for this program and the three centers which have been chosen by the Department of Commerce following the recommendations of a merit review panel of the National Research Council are described below.

DESCRIPTION OF THE CENTER PROGRAMS

The Automated Manufacturing Research Facility (AMRF) is a unique engineering laboratory at the NIST Center for Manufacturing Engineering. The facility provides a basic array of manufacturing equipment and systems--a "test-bed" that researchers from NIST, industrial firms, universities and other government agencies can use to experiment with new standards and to study new methods of measurement and quality control for automated factories. It includes numerically controlled milling machines and lathes, automated materials-handling equipment to move parts, tools and raw materials from one workstation to another, and a variety of industrial robots to tend the machine tools. It is a version of the "factory of the future" initiated by leading industry and is intended to encourage modernization of American manufacturing by providing the technical information to develop standardized interfaces between various types of equipment.

For even the largest firms the interfacing of complex equipment is costly, but for about 100,000 American discrete parts firms the problem is worse. These small companies (with less than 50 employees) make products in small batches, but these producers are responsible for about 75% of the total U.S. trade in manufactured goods. These small companies must buy automated machinery in stages, one machine at a time, and slowly build up to an integrated system. They need to buy from different manufacturers at different times with an assurance that the machines they buy will work together properly without costly retrofit. The companies must be able to switch quickly from one part to another without expensive reprogramming, and they must provide a mechanism to measure accuracy and provide feedback during the machining process rather than reworking out-of-tolerance parts or scrapping unsalvageable batches. It is estimated that one third of the U.S. manufacturing work force is currently engaged in reworking parts, and in some industries it is common to have scrap rates of 60% or higher.
The problems of protocol, procedure, and interface standardization must be solved while encouraging equipment manufacturers to continually develop new and innovative products. This is the rationale for the location of the AMRF at the NIST. The mission of the Manufacturing Technology Centers program is, therefore, to accelerate the transfer of the AMRF technology to small-and medium-sized businesses in order to make them market competitive while assisting the development of state-of-the-art equipment. Each center applies the techniques to the needs of the manufacturers located within its region.

The **Cleveland Advanced Manufacturing Program** (CAMP) is located at and publicly identified with the new 96,000 square foot Unified Technologies Center, a recently built facility for technology demonstration and training near downtown Cleveland on the campus of Cuyahoga Community College. It is a not-for-profit corporation with support from the Thomas Edison Program of the State of Ohio, and shares the talents and resources of other local universities and community colleges (Case Western Reserve University, Cleveland State University, and NASA-Lewis). Private corporation members include IBM, Hewlett Packard, TRW Inc., GE, Allen Bradley, BP America, Reliance Electric, Eaton and Parker Hannifin Corp. The Cleveland programmatic emphasis is on production machinery performance, manufacturing operations, expert systems, robotics, sensor technology, seminars and training.

The **Rensselaer Polytechnic Institute Northeast Manufacturing Technology Center** concentrates mainly on software related to material removal, robot controlled assembly and automated inspection of mechanical components for the automotive, consumer and electronics industries. The center includes the New York state extension network and will build upon that concept in applying it to similar extension organizations in other northeastern states. Support also derives from industry and two State of New York industrial extension services: the Industrial Innovation Extension Program and the Technology Development Organization. A particular thrust of this center is the "hardening" of NIST Computer Aided Design feature based software for development as commercial products.

The **University of South Carolina Southeast Manufacturing Technology Center** is a partnership with Clemson University and the 16 two-year technical colleges of South Carolina. The center focuses on 1250 discrete-parts, metal fabricating corporations (98% of which are within 25 miles of one of the partners). Its regional breadth will occur in the second year through an agreement with the Manufacturing Technology Council of the Southern Growth Policy Board representing 14 states. The emphasis of the center is on establishing an efficient delivery mechanism of NIST technology to USC, then to the technical colleges, and finally to local corporations. A unique feature of this system is that it is already in place and over 18,000 employees of this industry have already been trained by the colleges due to the "blank check" policy set by the state under then Governor Ernest Hollings. The activity will include company evaluation, demonstration and free training in CAD, CAE, downlink CAM to numeric machines, application of inventory control, quality control, metrology, robot servers, advanced machine tools and integration cells.

CURRENT STATUS OF THE CENTERS

The transfer of advanced manufacturing technology is the primary task of this program, rather than the performance of research. The first quarter activities of the centers have thus primarily included:

1. Educating the educators.
2. Preparing demonstrations on CAD, CAM, work cell control, interfacing, finite element analysis, and business control software.
3. Informing and educating industrial firms in each region about which advanced manufacturing techniques will be available.
4. Installation of equipment and preparation of training facilities.
5. Development of program staff.
6. Development of an industry survey instrument for evaluation.
7. Negotiation of agreements for expanding the program to other regional partners.

Activities of the second and third quarters will include:

8. Demonstrating advanced manufacturing techniques to interested corporations.
9. Evaluating the applicability of specific advanced technology to these firms.
10. Assisting firms in evaluating their requirements and business plans.

Activities for the remainder of the year will include items 1 to 10 for new firms and:

11. Assisting with the implementation of desired applications.
12. Supporting corporate work-force training and retraining.

Activities in successive years will include items 1 to 12 for new firms and:

13. Expanding experiences to regional and national audiences.

Each of the three initial centers is starting from different strengths and different initial interests. However, the center directors meet once per month to compare notes. This comparison promotes beneficial cross-fertilization between the three centers.

For those of us who maintained a healthy skepticism about the likelihood of corporations really seeking assistance from "the egg-heads of the ivory tower environment", the response of industry has been overwhelming. This may be due to the fact that the primary source of past information was via equipment vendors, some of whom were primarily motivated by their own marketing strategies. The NIST/ university approach provides, at the least, an objective assessment of a corporations requirements by engineering and business professors who have experience in the real world. And since many of the employees and managers were taught by the schools and instructors who are a part of this program, they have maintained a healthy degree of trust.

The fact that the NIST requires a one for one leveraging of Federal dollars by universities and states has insured that the goals of the Centers were in line with local priorities for economic development. At USC we have also found some unexpected interest from large corporations who are partners in other technology transfer activities. At a recent meeting which included representatives of Westinghouse Nuclear Fuels, Westinghouse Savannah River Site, NCR, Square D, Sonoco, Homelite, Rockwell, Cooper Air Tools, and Digital Equipment, unusual interest was shown in providing the small-to-medium-sized businesses with information about subcontract specifications and compatible automation technologies.

It is, of course, too early to predict the general economic benefits which will result from these centers, but we believe that a recent example for an individual company is instructive. A small South Carolina company which had 150 employees only a few years ago, is now down to 35 employees, most of whom are minority. Its machines are primarily of the 1940 vintage. Its owner wants to bid on a contract from a defense manufacturer, but cannot meet stated technical specifications due to a lack of quality control and proper documentation. The USC center is providing preliminary engineering evaluation for one new tool that is needed, and a new system for providing inventory documentation. With an upgrade of the equipment and training for his personnel, the owner can bid on such contracts in the future. A search for a lending institution for the equipment is underway.

FUTURE POTENTIAL OF THE CENTERS

Once the three centers have established a pattern of success in their own localities, they will be ripe for replication. The plan for that expansion into their regions is under formulation for the successive years of the program. The expansion into other parts of existing regions is expected to cost an additional 10% at a minimum but additional support for new states in the same region would be valuable. However, national success will be accelerated by a larger coverage of the country. Other areas which could profit from the centers include the southwest, the northwest and possibly another center in the far midwest. Expansion into three new regions would be expected to cost an additional 50% in the first year, and an additional 100% in out years.

Eventually, if the centers are judged to be successful, it is conceivable that the program could be expanded to include other disciplines (such as process manufacturing; polymers, injection molded plastics, and fiber optic cabling,..) and other laboratories (such as the DOE National Laboratories or the DOD defense laboratories). A marriage with appropriate industry also seems natural; some industry partners have already associated themselves with the three centers, but the development of cross sector standards between computer-aided design corporations and manufacturers of machine tools, for example, will be mandatory. Finally, the customers of the small-to medium-sized corporations need to become a part of the solution. If, for example, one of the procurement offices of a defense agency would agree to allow the centers to certify the small corporations which meet technical specifications, an additional incentive would be provided for the companies to standardize and modernize due to anticipated future defense contracts.

One of the characteristics of the three centers is that they have all been involved in technology transfer programs previously with large corporations who could afford to pay for services rendered. As an example, I cite the case of electronic component identification and placement on integrated circuit boards for the NCR corporation. Several years ago NCR and USC concluded that a project should be undertaken between an engineering research group at the university and a corporate product line team at NCR. They devised two identical systems, one in the research lab and one on the manufacturing line. A digitized video camera and the appropriate software for geometric identification was developed in which automated review of components and their precise location was carried out prior to soldering. The process involved regular exchange of personnel between the two facilities and ideas continued about improving the product in quality and in speed. Now the process is touted by both partners and is studied by successive generations of students. This research mode of interaction can become a valuable complement to the current delivery system of the NIST centers.

CONCLUSION

A recent study on The State of Computerized Automation in U.S. Manufacturing by the John F. Kennedy School of Government at Harvard University concludes that by 1987 among U.S. metal-working establishments:

- Less than 11 percent of the machine tools in use are computer controlled.
- 53 percent of U.S. plants have not installed even one automated machine that is computer controlled.
- Of those plants that have adopted the technology prior to 1982, 1 in 4 have not made any additional investment in the new technology.
- Even among the plants that have invested in computerized automation within the last 5 years, the use of the equipment in their production operations is only about 1 in 6.
- Most automation is occurring in large plants (500 or more employees) and only 1 in 10 production managers where there is no automation have plans for investing in 1988/89. The reason? "Accounting rules of thumb say short run payback is insufficient."
- There is no inherent conflict between technology upgrades and the long-range interests of workers as long as classes for the new skills are provided by the employer; however, in 84 percent of the plants with some programmable machines, no classes have been provided and three quarters of machine operators have yet to address the question.
- For managers in small, single-plant firms, equipment vendors are the primary source of training. No broad based training on the whole range of computerized equipment to machine operators, managers, and programming specialists is now being provided.
- Most U.S. enterprises lack the capacity for long range planning, and need assistance to devise better business strategies to exploit the economics of computerized automation.
- There is not a coherent national system of vocational training to fill the gap for on the job training and a well-rounded, versatile work force that is knowledgeable about computerization.
- In most cases, unions are failing to protect blue-collar jobs from "deskilling" through traditional collective bargaining.

The Harvard group was apparently not aware of the existence of the NIST program. This program has the potential to address each of these problems and is one of the few government initiatives which will allow our manufacturers to effectively compete in global markets.

In 1986 the Southern Growth Policies Board produced a document entitled Halfway Home and a Long Way to Go, the report of the commission on the future of the South. It consisted of the details of ten regional objectives which could as easily apply to other areas of the nation. Five of the ten recommendations were:

- Prepare a flexible, globally-competitive work force.
- Increase the economic development role of higher education.
- Increase the regions capacity to generate and use technology.
- Implement new strategies aimed at home-grown business and industry.
- Develop pragmatic leaders with a global vision.

These are all components of the NIST Manufacturing Technology Centers program. The same conclusions have been reached at a regional and at a national level. In that some document a worthwhile evaluation was stated:

> The familiar song says that old times in Dixie are "not forgotten." William Faulkner adds that in the South the past is not only not forgotten - it's not even past! History is to a people what memory is to an individual, and too often the Old South preferred the past, resting by the roadside swapping tales of yesterday, postponing changes until the weather cooled, the crops were in, or the moon was in the right phase. We dare not retrace that long, weary road. To honor the past is one thing. To prefer it will cost us the future.

We congratulate you, Mr. Chairman, for having the foresight to protect our future by creating the Manufacturing Technology Centers and the Department of Commerce for providing excellent managers to coordinate the program.

The CHAIRMAN. Thank you, doctor. Mr. Weinert?

STATEMENT OF DONALD G. WEINERT, P.E., EXECUTIVE DIRECTOR, NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Mr. WEINERT. Thank you, Mr. Chairman. I am Don Weinert, Executive Director of the National Society of Professional Engineers. Our organization has about 75,000 engineer members nation-wide, including chapters in Puerto Rico and Guam and Panama.

Two years ago, I had the honor of coming before the Committee to testify in support of some new concepts, some innovative ideas expressed in S. 907, and I attached a copy of that testimony, just so that you could go back and see that our support today is as steadfast as it was then.

I am delighted, of course, that last year in the Omnibus Trade and Competitiveness Act we got those provisions pretty much into law, and today what I would like to do is shift focus from support of good ideas and innovative approaches to improving our technological competitiveness, to getting down to the business of allocating resources to do what we have to do in this country, and that is going to be the focus of my testimony here.

Now, first let me just give some perspective, or at least our perspective, on the status of the U.S. technological base as sort of a framework. In our view, the problem is not a lack of ideas and new technologies or knowledge, it is a problem of getting those ideas and that knowledge to the people who can use it, who can turn it into productive products, services and, things that are going to fuel our economy and make us competitive globally.

A second weakness besides the inability to get that transfer going quickly, we think, has been a lack of a Federal focus to provide leadership in this area. If you will recall in my testimony two years ago, I likened the role of Commerce and our national commercial security to that of the Department of Defense and our military security, and I think that is still an appropriate comparison.

We think that what has been taking place in creating these new roles for the Department of Commerce is absolutely appropriate in allowing Commerce to become the focus that we have needed for constructive Federal involvement in the civil technology development and transfer system.

Now, I have one other thing I would like to say about our technology base that is sort of outside the scope of this particular hearing, but I think it was mentioned earlier and I think it bears repeating.

The problem we have with education—the K through 12 and the undergraduate engineering education system—is a big one, a real one, and we can solve all of these Federal focus, tech transfer issues and be nowhere if we do not also solve the educational issue, particularly as it relates to math and science in the K through 12 arena.

It is forecasted that by the year 2010 people are forecasting shortages of 700,000 engineers, perhaps, in this country based upon what we project our needs to be at that time. Clearly, we have got to get to work in our education system.

Let me just talk for a moment about the subject of Federal leadership. We do believe Commerce is the appropriate focus—and by the way, we think creating the position of Under Secretary of Commerce for Technology is a step in the right direction. I guess we are a little disappointed that the person has not yet been appointed, so that that leadership role can begin to take place. But we understand the problems associated with making those appointments. We certainly urge the Administration to get on with making that critical appointment, because we think that the Under Secretary is going to be critical to the Federal leadership role.

Now, let me comment for a moment on the existing scientific and technical programs at NIST, because I think we typically think of these things as either-ors. Either we are going to do these new initiatives, these new programs on technology transfer, or we are going to preserve the core programs at NIST.

I think it is ridiculous for this country to think in terms of either-or with sums of money that we are talking about—$155 million for the core programs. Even if it were three times that amount, it would not even be rounded in the Department of Defense budget.

We were talking a minute ago about Cray computers that cost $20 million and we say in a few years they may be down to $300,000 and $400,000. The savings on each one of those computers when aggregated would more than offset any amount of money you invest at this time.

So I do not think of this in terms of either-or; I think in terms of both, and looking at those core programs—setting those technical standards and research; the properties of new material that Mr. Kammer discussed—those are critical to industry, providing industry with physical and chemical measurement technologies, standards and reliable data critical to industry.

In the National Engineering Lab that we mentioned earlier, the Fire and Building Safety Program—some of the work they are doing out there might help us figure out ways to make buildings safer from that tornado that touched down in South Carolina this morning, in your state.

The AMRF also in the National Engineering Lab, is a tremendous facility with some of the most advanced, flexible automated manufacturing techniques in the world. A key tie to remember, though, is what we learn from the AMRF is going to be used in these centers that we have been talking about. There is a tie between the core programs and some of these new initiatives, a very important tie, and if you have any doubt about the value of the core traditional programs at the National Institute of Standards and Technology, just look at the record.

There are more than 200 people out there from industry. Industry is sending their employees to work with the scientists and engineers at NIST, in the NIST research associate program. Industry would not be sending more than 200 people out there to work with those scientists and engineers at NIST if those programs were not of value.

Now, just let me turn quickly to some of the new programs. As I pointed out, that strong cadre of technical people out at NIST and that essential scientific involvement and activity is what we think makes NIST well-suited for these new initiatives and new missions.

The centers—I just want to make one comment on the centers. We certainly endorse the value and the idea of the centers. When we get around to talking about resources, let us go ahead and fund them for at least three years.

We cannot test those things and see if they are going to work if we are just going to fund them for one year, or even two years. Let us get enough money to fund them for three years.

We are working with the Institute of Industrial Engineers and the Society of Manufacturing Engineers and have convened a little team of engineers that will be helping evaluate the effectiveness of the centers.

It is headed by Dr. Lee Martin P.E. from Tennessee who heads his own small robotics firm which was built on technology that came out of the Federal lab system, so he certainly understands the value of tech transfer. We plan to send engineers to use the centers and give an objective assessment of how effective they are and report back both to the Congress and to NIST to help them make them all they can be.

The Technology Extension Service—a lot has been said about that. It is not going to take much money, but it is going to be so important. The point was made that we have to figure a way to network all this information, to make it available.

Well, there are all kinds of Federal and State extension services already existing. If we just had somebody like NIST go in and network them, identify them, tie them together, we have made great progress at very little investment.

The advanced technology program that you all have talked about—we need to take some risks, some chances. We need to take leadership. We cannot always expect the private sector to rise up and say, this is what we ought to do and make the right decision. The Federal Government does have a legitimate role to be a partner in this process. We think the advanced technology program is important.

The Clearinghouse for State Technology Programs—I am sure you are aware that there are technology programs in every state in this country, but there is not a lot of consistency among them, among the terminology. There is not a lot of coordination.

One of the things that NIST proposes to do in these new initiatives is set up a database, tie these technology programs together that exist, so if they can network the extension services and the technology programs we will have accomplished a great deal without spending very much money and that is my point: a small investment, big dividend.

So let me just close by making this plea, I guess, and I know the Committee is faced with the same kinds of difficult choices as the entire Congress. At a time of limited Federal resources, where do you put your money?

Well, it is clear to me that we need to make critical investments in the future with our money and I cannot see why we cannot come up with not only the money for the core programs of NIST but also a substantial sum of money to go ahead and fund these new initiatives.

The total amount could not even be $200 million, or if it is, what is that in the great scheme of the Federal budget compared to, say, any of the Defense budget?

Where do we get it? I think Defense is interested in some of what NIST is proposing to do. I think that there should be a partnership. Maybe we ought to investigate the possibility of some sharing of resources there.

I am sure that my friends in the Defense Department would not appreciate that comment. As you know, Senator, I spent a good number of years in the military service, but I think it is time for the country to look together at how to solve its problems and we need to find the resources.

Thank you.

[The statement follows:]

STATEMENT OF DONALD G. WEINERT, P.E., EXECUTIVE DIRECTOR, NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Mr. Chairman and Members of the Committee:

I am Donald G. Weinert, P.E., Executive Director of the National Society of Professional Engineers (NSPE), a membership society of over 75,000 engineers employed in industry, education, government, private practice and construction. Thank you for inviting me to discuss NSPE's perspective on the status of the U.S. technology base and the contributions of the National Institute of Standards and Technology to U.S. technological competitiveness.

In 1987, NSPE was pleased to register its support for the Technology Competitiveness Act (S. 907), which outlined important cooperative initiatives between national laboratories, industry and state government in the effort to improve U.S. industrial productivity. Last year, we were delighted to see provisions of your bill included in the 1988 Omnibus Trade and Competitiveness Act. We were especially pleased that three of the Centers for the Transfer of Manufacturing Technology were funded and are now operational, although I believe it was a mistake to fund those centers at the expense of the Institute's core program budget. The National Institute of Standards and Technology is developing technology outreach programs that show great promise in improving the U.S. manufacturing enterprise. I wish to reaffirm NSPE's support for the S. 907 initiatives, as outlined in our 1987 testimony (attached for reference), and commend the excellent, ongoing work performed by NIST.

Today I wish to shift my focus from support of the concepts of S. 907 to the allocation of adequate resources for both NIST's ongoing core programs and the new programs for technology transfer. With a relatively small investment of federal dollars, NIST can provide high dividends to the U.S. economy.

Status of U.S. Technology Base

Let me first make a few comments on the status of the U.S. technology base. The principal weakness of the U.S. technology base is not a lack of new ideas and technologies. Rather, it is the lack of an effective transfer system that allows small manufacturing firms and independent inventors ready access to the ideas so they may be converted to useful products and processes.

It is NSPE's position that the best strategy for strengthening the U.S. technology base is to create a system that facilitates the flow of available knowledge and ideas to the entrepreneurial inventors and small- and medium-sized manufacturers who can use this knowledge to the benefit of the U.S. economy. Unlike large industry, which already has a strong technology transfer network, small firms often do not have the resources to access new ideas. We need to make a concerted effort to network all technology information sources and cultivate new and innovative ways of moving information to the small- and medium-sized manufacturer.

The NIST Centers for the Transfer of Manufacturing Technology are designed specifically to assist such small- and medium-sized firms in applying modern technology to their operations. The centers now becoming operational at the Cleveland Advanced Manufacturing Program in Ohio, Rensselaer Polytechnic Institute in New York, and the South Carolina Technology Cooperative show great potential for success.

Another project promising to facilitate the flow of information is being conducted by NSPE under a cooperative agreement with NIST. The project will produce generic definitions of the engineering stages that a new product or process goes through from conception of the idea to production. The definitions immediately will be applied in the management and evaluation of the NIST/DOE Energy-Related Inventions Program, but will have other important applications as well. NIST expects to use them in its work under the Industrial Extension Services Program, authorized by the 1988 Trade Act. Working with a network of local Resource Centers to foster the commercialization of technology, NIST will use them both in day-to-day operations and as a basis for educational curricula and training programs for the centers' technical extension agents.

Federal Leadership

An effective support and knowledge transfer network requires federal coordination and leadership. It also requires a solid technical base to draw upon, such as the traditional NIST programs. These programs are prepared to address new technical issues associated with emerging technologies. The 1988 Trade Act identifies the Department of Commerce as the lead federal agency for coordinating U.S. civilian technology. We believe Commerce is the logical home. As I stated two years ago before your committee, the Commerce

Department's role in U.S. commercial security can be likened to that of the Department of Defense in military security. Moreover, the new Technology Administration in the Commerce Department appears to be a step in the right direction for applying vision and planning to U.S. technology development and transfer. We are disappointed that the Undersecretary of Commerce for Technology has not yet been appointed to begin this leadership.

National Institute of Standards and Technology

Scientific and Technical Research Programs

The scientific and technical research programs of NIST, from setting technical standards to researching the properties of new materials, are vital to U.S. industry. In particular, the Institute's National Engineering Laboratory conducts valuable research in such fields as electrical and electronic engineering, manufacturing technology and building and fire research. Within the NIST core programs are important new initiatives such as lightwave measurement technology, high temperature superconductors and high performance composites that are directed to the technical issues that must be addressed if we are to capture the benefits from these emerging technologies.

The NEL works on problems related to public health and safety through its Fire and Building Safety Research programs. Examples include testing for building structural integrity, determination of properties of materials that affect performance in earthquakes, winds, storms and fire, and development of refrigerants that do not deplete the ozone layer, to name just a few. The Building Research Program also includes work on computer-integrated construction, which is helping the United States maintain competitiveness in the construction industry. We urge the Congress to continue to fund and provide for the growth of this program.

The Automated Manufacturing Research Facility (AMRF), operated out of the NEL's Center for Manufacturing Engineering, is a state-of-the-art facility that performs a unique and important role in the U.S. manufacturing enterprise. The AMRF performs specialized research in new measurement methods and quality control techniques and incorporates some of the most advanced, most flexible automated manufacturing techniques in the world. Innovations from the AMRF will be utilized by the manufacturing technology transfer centers.

Perhaps the best example of the value of NIST's core scientific and technical research programs is the fact that companies, through NIST's Research Associate Program, pay their engineers and scientists to work in NIST laboratories. The program currently has more than 200 participants.

The core programs of NIST provide industry with physical and chemical measurement technology, standards and reliable data that are crucial to enhancing industrial productivity. To meet the competitive challenge of international markets, the original mission of this vital government laboratory must not be compromised. We were distressed last year to see funding for new initiatives at NIST taken out of the budget for critical core programs.

New Programs

NIST is uniquely qualified to take on new challenges in technology transfer because of its strong cadre of technical people and the essential measurement and standards research it has conducted since 1901. We believe NIST is well-positioned to take on the programs outlined in S. 907 to strengthen U.S. technological competitiveness. It is appropriate, in response to the global challenge for market share, to redefine the role of government labs. We would caution the Congress, however, that without an established base of research, these new programs will be worthless.

New initiatives should be built upon the strong foundation of research that exists at NIST. If this is accomplished, NIST has an ideal opportunity to serve as a catalyst in the technology development and transfer so essential to improving the United States' ability to compete in the global market. The manufacturing technology transfer centers program, for example, is designed to leverage matching funds from other sources and encourages partnerships with state governments, industry and academic institutions.

Of course, it is unfair and unwise to call a new mandate for NIST an "opportunity" without providing additional resources for its implementation. Of all the programs authorized, only three of the 12 manufacturing technology transfer centers were funded in FY 1989 and then for one year only. The other programs--Technology Extension Services, an Advanced Technology Program and a Clearinghouse for State Technology Programs--were not funded at all. Most unfortunately, even these minimal start-up funds were taken "out of the hide" of the vital core NIST programs.

During deliberations on the FY 1990 NIST budget, NSPE urges the Congress to fund both NIST's core programs and the new programs authorized by the Trade Act. As such, we urge an overall increase in this important agency's relatively small budget. NSPE advocates funding the three existing manufacturing technology transfer centers for at least three years. The centers are currently holding up their end of the bargain by negotiating for industry support. They want the chance to succeed. The centers need more than one year to become fully operational, to honor commitments, and ultimately, to measure success.

NPSE is prepared to assist in evaluating the success of the centers program. We have formed an independent review committee composed of distinguished engineers from NSPE, the Society of Manufacturing Engineers and the Institute of Industrial Engineers. That committee will help promote, monitor and evaluate the appropriated centers over the next three years. NSPE member H. Lee Martin, P.E., is chairman of the review committee. Appropriately, Dr. Martin owns a small robotics firm representative of a technology-based start-up company founded on technologies developed in government labs.

The review committee will enlist engineers near the centers, provide them with evaluation criteria and analyze their feedback in order to report useful data to NIST and to the Congress. We hope to answer such questions as: 1) Do the centers reach beyond the immediate vicinity? 2) What materials do manufacturing engineers need? 3) What are the most/least effective programs the centers provide? 4) What areas of information are most needed to compete in the marketplace? We will be forthright in offering suggestions for improvement. It is hoped, however, that the program will be successful enough to justify funding the additional centers as authorized so that many more engineers around the nation can use the centers, and more regions can benefit. To this end, NSPE can use its nationwide grassroots network of 535 chapters to help promote the centers.

We believe that the other programs authorized by the 1988 Trade Act--the Technology Extension Services, Advanced Technology Program and the Clearinghouse for State Technology Programs--also have great potential for improving U.S. industrial productivity. Activities planned for the NIST Office of Industrial Extension Services, if funded, would enable the Institute to work better with existing state technology extension services. For example, the program would make federal technology available to small- and medium-sized businesses through existing state and federal extension services. NIST also proposes to help structure workshops to assist businesses in solving common problems. A central technology database such as this will improve the flow of new ideas through the existing network of extension services.

NSPE also believes the proposed Advanced Technology Program at NIST could fill a critical void in the area of emerging technologies by encouraging the formation of industry consortia. In the absence of private sector initiatives, we believe it is appropriate for federal leadership to encourage joint ventures in technology commercialization.

Finally, the NIST Clearinghouse for State Technology Programs would coordinate technology policy that varies from state to state. We support this effort for its attempt to encourage technology programs that are consistent with national goals.

Conclusion

NPSE is encouraged by the new opportunities NIST has in facilitating technology transfer, the key to improving the U.S. technology base. We must be careful, however, that new programs are not funded at the expense of the Institute's core programs. NIST needs adequate resources to continue critical core programs, begin promising new ones, and provide the talented staff necessary to support all programs.

We appreciate the difficult choices the Congress faces in allocating limited federal dollars to seemingly unlimited needs. We submit that an investment in NIST would take only a small part of the federal budget pie while producing large short-and long-term payoffs in improving the U.S. technology base.

The world economic scene will change dramatically in 1992 when the European Economic Community achieves full economic integration. Europe will be a powerful competitor. Japan shows no sign of weakening. Small nations in east and southeast Asia show great vitality. To compete in that world arena, we have to be flexible and responsive. We cannot wait for things to happen in the traditional way. The NIST programs are not the entire answer, but if properly funded, they can be a big step in the right direction. Moreover, they can complement other efforts to improve industrial productivity. The Administration's proposed cut in the capital gains tax, for example, will not achieve its full effect unless the small entrepreneur has the necessary knowledge that will enable him to produce high-quality, state-of-the-art products.

The economic future of the United States is at stake. The relatively small investment represented by the National Institute of Standards and Technology budget will go a long way toward strengthening the U.S. technology base and the U.S. economy.

Thank you, Mr. Chairman, for the opportunity to present these views.

The CHAIRMAN. Thank you very much. Ms. Hubbard.

STATEMENT OF PAT HILL HUBBARD, VICE PRESIDENT, SCIENCE AND TECHNOLOGY POLICY, AMERICAN ELECTRONICS ASSOCIATION

Ms. HUBBARD. Mr. Chairman, it is a real pleasure for me to be invited back to speak to you and the Committee on behalf of AEA. We represent about 3,500 electronics and information technology companies and I am proud to say 45 U.S. engineering universities as well, and actually since NIST is certainly interested in the small company, let me just say that two-thirds of AEA's 3,500 companies are what we call small—under 200 or fewer employees.

I really appreciate talking about NIST and its role and how it can help improve and keep America's electronics industry competitive and I also appreciate having another opportunity to discuss the development of a U.S.-based ATV, or advanced television industry and the potential role that NIST might play in that as well.

I am just abandoning my written testimony totally and I have jotted down a few notes that hopefully will not replicate my distinguished colleagues on this panel. Let me just make some points. I think they drive a lot of what is behind the Boston Consulting Group recommendations which AEA has brought forth.

One is that manufacturing matters to this country. A service job, an assembler job, is not the same as an engineering job. There's a difference in education required, a difference in salary provided and generated and therefore a contribution to the general tax base of this country, and in job creation for others.

Our BCG plan was really a response, I think, to what John Lyons mentioned in terms of Japan's key technology centers. The first strategy is to get together and we did that, in spite of great concern about antitrust. We brought companies together and we came up with a plan.

That plan is not in concrete. It is meant as a beginning of a debate. It is adjustable. There are some key elements, however. One is, we have got to have some R&D. We need to use standards in a way that advantage the U.S. and we have to deal with the high cost of capital when we talk about manufacturing products and we need to—just like Japan and Europe—need to do what we call pump priming, and that is to make the customers aware of the value of the technology, because if we do not do it here in this country, the Japanese and the Europeans again will do it for us.

The catch-up costs are high. We do not have a manufacturing, marketing or distribution infrastructure in this country. We are behind in the technologies. There is a long-time horizon involved in this issue of ATV, or advanced technologies. We have to be in it in the 1990s, where there will be low return in order to be positioned for the spin-off markets with high return in the year 2000 and beyond.

I would like to make a point that we, the U.S. manufacturers, are the outsiders in much of the debate that is going on in this country. The insiders are Europe and Japan and Zenith.

Therefore the issue is very different than a Sematech. In Sematech you have companies who are trying to keep the wolf from, you know, the door today. They are trying to build a manufacturing technology process, technology that they can take back right now today and use to make their products more competitive.

ATV may begin with television. It will not stop there. But nevertheless it begins with television in the consumer market, which we are out of. The only commonality with the group of companies that we have been working with comes—is their differences. They are outsiders. They cannot use the technology right this evening, and they face corporate structures that do not understand the wolf five miles down the road and so you have a very different situation going on here.

It is a cost of capital issue. I want to just go on record as saying, as a cornerstone of AEA's public affairs agenda is to reduce the deficit—to reduce the cost of capital, to make permanent the R&D tax credit and to reduce capital gains as a means of stimulating entrepreneurship and competitiveness in general.

In terms of the five-year plan—and it is a five-year plan. I got up this morning to turn on the news. Honestly, I turned it on and saw Dick Wiley ask somebody from an FCC commission if they approved of the $1.3 billion AEA wanted. That happens to me a lot these days and so let me just correct, if I may, a couple of things.

One is, this is a partnership idea we are proposing. It is not a subsidy as has been reported in the press, and we are doing, again, the proposal in response to really what Congress asked us to do.

What is it going to take to do this industry? Unfortunately, it is going to take some dollars. Industry is quite willing to meet at least half-way if not more, with the government. But they cannot do it alone for some of the reasons that I iterated to you.

We need the technology developed. DARPA has certainly an initiative going. We commend it highly, and therefore we looked at what it is going to take to really fund the full funding for those 49 proposals and we think it is about $100 million a year for three years.

We have looked at how you manage the whole process and it is an awesome process and we devised something which, frankly we very incorrectly named, and that was something called an ATV Corp. Really, I am going to abandon the term "corporation" and call it an ATV advisory entity, because that is all it is.

It is a group of industry, academia and government people chaired by industry. Majority members probably should be industry and I think most people would agree with that, and it is a management entity and it could be appointed today. It is not going to cost money—a few staffers, et cetera—and we believe that standards can be used in a creative way to again create a domestic industry.

In fact this allows me at least at this moment, if I may, to correct Mr. Kammer, who made some very good statements about HDTV and NIST's role in it, but one he mentioned was our intention to have NIST develop the standard. Let me clarify.

Our concern, when we looked around at the standards process is that as I understand it only five of the 14 viable, possibly viable standards groups will be able to be up and running and testable by the end of 1990—only five.

Of those, they have got to pay—again my understanding is to build those systems, so they are going to be large companies. Money through NIST to help build prototype standards systems would—our intention would be that small companies, breakthrough technology, et cetera, could also benefit from those grants, if you will, and that NIST's role would be to again help the prototypes to be built, that the testing would go on just in the normal testing and that FCC might look to NIST and say, so what do you guys think? You know, you are the measurements people.

So again, we are looking at a way to accelerate the process for building those standards and testing them and felt that NIST could play a pretty key role, especially if it was determined by Congress and the FCC and the Administration, that there was some way to have the ownership of the underlying—the signal format underlying a standard patentable and owned by the government so it could control a little bit the licensees and ensure that a domestic industry was developed.

Lastly, in terms of the low-cost loans, which again get lumped as the one point—one point billion dollars, this is a five-year program. We envision these downstream. There may be some other ways to generate those funds for manufacturing, but we have got a whale of a cost of capital problem in this country.

Also Mr. Kammer I think misread the report. He talked about that money being used to build vertically integrated complexes. How wonderful, but what a high price tag and how, really it is not our intention. We are looking at even a single company, a small company applying for those manufacturing low-cost loans.

Again, in all of this, a co-investment by industry. Industry votes with its pocketbook and if it does not think it is going to get that dollar back it tends not to give it, believe me. I have been raising money for education from industry for a long time and I know something about that.

I guess the final thing that I might say is that when we looked around at who could play a leadership role in the commercialization in the civilian part of all of this, we did not see too much in Washington, other than DARPA, which again has its own constituency.

But we did look with great appreciation, senator, to you and your Committee and the creation in the trade bill of NIST and its potential role in this and we felt like this was a real opportunity to put some money—not to, in any way to diminish the metrology role. Believe me, I can switch hats here and tell you about how strong metrology is. John Fluke has done a wonderful job of it.

But to also take advantage of this opportunity, it is a new global marketplace. We are going to be having, I hope, to do additional industry-government activities together and NIST is a counterpart to DARPA and a leadership role is just essential.

So we commend you, and we are here to support that initiative. Thank you.

[The statement follows:]

STATEMENT OF PAT HILL HUBBARD, VICE PRESIDENT, AMERICAN ELECTRONICS ASSN.

ON BEHALF OF THE AMERICAN ELECTRONICS ASSOCIATION (AEA), WHICH REPRESENTS SOME 3,500 U.S. ELECTRONICS AND INFORMATION TECHNOLOGY COMPANIES AND 45 U.S. ENGINEERING UNIVERSITIES, I WANT TO THANK YOU FOR THE INVITATION TO TESTIFY ON THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) AND THE ROLE NIST PLAYS IN ADVANCING AMERICA'S ELECTRONICS INDUSTRY. I ALSO APPRECIATE HAVING ANOTHER OPPORTUNITY TO DISCUSS THE DEVELOPMENT OF A U.S. BASED ATV (ADVANCED TELEVISION) INDUSTRY AND THE POTENTIAL ROLE NIST COULD PLAY IN ASSISTING COMPANY-LED EFFORTS TO DEVELOP ATV.

U.S. COMPETITIVENESS

COMPETITIVENESS IS A TWO-STEP PROCESS--THE DEVELOPMENT OF LEADING EDGE TECHNOLOGIES AND THEIR SUCCESSFUL COMMERCIALIZATION. ALTHOUGH THE U.S. REMAINS A WORLD LEADER IN INNOVATION, OUR SKILLS IN PRODUCT AND PROCESS DEVELOPMENT AND PRODUCTION--CRITICAL TO PROGRESSING FROM THE LABORATORY TO THE MARKETPLACE--ARE LESS THAN WORLD CLASS. WITH INCREASING FREQUENCY, THE U.S. IS BEING OUTPERFORMED BY FOREIGN COMPETITORS IN THE DESIGN AND MANUFACTURE OF COST-COMPETITIVE, HIGH-QUALITY PRODUCTS.

THE U.S. IS A COUNTRY FULL OF CREATIVE, INNOVATIVE ENTREPRENEURS. THIS IS DUE IN LARGE MEASURE TO THE UNPARALLELED QUALITY OF U.S. UNIVERSITIES. THE DEVELOPMENT OF SUCH COMMON PRODUCTS AS THE PORTABLE RADIO, TELEVISION, STEREO, FM RADIO, VIDEO GAMES, AND VCRs CAN BE TRACED DIRECTLY TO THE RESEARCH CAPABILITIES OF

AMERICAN SCIENTISTS AND ENGINEERS. DESPITE OUR GAINS IN THE DEVELOPMENT OF ELECTRONIC PRODUCTS, HOWEVER, WE HAVE BEEN UNABLE TO SUSTAIN MAJOR MARKET SHARE OF THESE PRODUCTS IN THE GLOBAL MARKETPLACE.

AND WHILE THE U.S. HAS BEEN OUTSTANDING AT CREATING TECHNOLOGY, OTHERS HAVE BECOME MASTERS OF PROCESS/PRODUCT DEVELOPMENT--GETTING THE TECHNOLOGY OUT OF THE LAB AND INTO THE HANDS OF CUSTOMERS.

JAPANESE TECHNOLOGY

JAPAN'S MINISTRY OF TRADE AND INDUSTRY (MITI) ANNOUNCED IN A DECEMBER 1988 REPORT THAT JAPAN HAS CAUGHT UP WITH OR SURPASSED THE U.S. IN MOST KEY ELECTRONICS TECHNOLOGIES. MITI ANALYZED 40 KEY HIGH-TECHNOLOGY PRODUCTS WITH LARGE GROWTH POTENTIAL AND CONCLUDED THAT JAPANESE TECHNOLOGY EQUALED OR SURPASSED THAT OF THE U.S. IN 90 PERCENT OF THE CASES.

BETWEEN 1976 AND 1986, R&D SPENDING IN JAPAN'S ELECTRICAL AND ELECTRONICS SECTOR TRIPLED. R&D SPENDING CLIMBED FROM 3.7 PERCENT TO 5.5 PERCENT OF SALES. ONLY 4 PERCENT OR SO OF JAPANESE CORPORATE R&D SPENDING IN ELECTRONICS GOES FOR BASIC RESEARCH; 18 PERCENT GOES FOR APPLIED RESEARCH. MOST OF THE R&D MONEY--78 PERCENT--GOES FOR PRODUCT DEVELOPMENT. ONLY A SMALL PORTION OF JAPAN'S R&D EXPENDITURES GO TO MILITARY R&D; DEFENSE R&D IN THE U. S. ACCOUNTS FOR ALMOST 2/3 OF ALL U.S. FEDERAL R&D SPENDING.

IN A RECENT COMPARATIVE STUDY OF INDUSTRIAL RESEARCH AND DEVELOPMENT IN JAPAN AND THE U.S., EDWIN MANSFIELD OF THE UNIVERSITY OF PENNSYLVANIA FOUND THAT U.S. COMPANIES DEVOTE ONLY ONE-THIRD OF THEIR R&D EXPENDITURES TO THE IMPROVEMENT OF PROCESS TECHNOLOGY; THE OTHER TWO-THIRDS IS ALLOCATED TO THE DEVELOPMENT OF NEW AND IMPROVED PRODUCTS. IN JAPAN THOSE PROPORTIONS IN R&D EXPENDITURES ARE REVERSED.

AMERICAN COMPANIES ALSO HAVE LAGGED BEHIND THEIR FOREIGN COMPETITORS IN EXPLOITING THE POTENTIAL FOR CONTINUAL IMPROVEMENT IN THE QUALITY AND RELIABILITY OF PRODUCTS AND PROCESSES. AS JAPAN HAS PROVEN SO WELL, THE CUMULATIVE EFFECT OF INCREMENTAL IMPROVEMENTS IN AND MODIFICATIONS OF ESTABLISHED PRODUCTS AND PROCESSES CAN BE SIZABLE. IT MAY EVEN OVERSHADOW THE COMMERCIAL VALUE OF TECHNOLOGICAL BREAKTHROUGHS.

WHEREAS THE GOVERNMENTS OF MANY OTHER INDUSTRIALIZED NATIONS HAVE PURPOSEFULLY PROMOTED RESEARCH AND TECHNOLOGY LEADING TOWARDS ECONOMIC DEVELOPMENT, U.S. POLICY FOR SCIENCE AND TECHNOLOGY TRADITIONALLY FOCUSES ON BASIC RESEARCH. THE COMMERCIAL DEVELOPMENT AND APPLICATION OF NEW TECHNOLOGIES HAS BEEN AND SHOULD CONTINUE TO BE THE PRIMARY RESPONSIBILITY OF THE PRIVATE SECTOR.

COMPETING IN THE GLOBAL MARKETPLACE

HOWEVER, SEVENTY-THREE PERCENT OF OUR FOREIGN TRADING PARTNERS DO NOT OPERATE WITH THE SAME FREE/FAIR TRADING PRACTICES AS DOES THE UNITED STATES. INCREASINGLY IN EMERGING NEW MARKETS U.S. COMPANIES ARE FINDING THEMSELVES LOOKING UP INTO THE FACE OF "COMBINES" OF MULTI-NATIONAL FOREIGN-BASED COMPANIES, SOME WITH SIGNIFICANT GOVERNMENT R&D SUPPORT AND CAPITAL COSTS LOW ENOUGH TO SUSTAIN LONG-TIME HORIZONS FOR INVESTMENTS.

FOR THE U.S. TO COMPETE IN THESE INSTANCES, SOME NEW PARADIGM OF COOPERATION INVOLVING GOVERNMENT, BUSINESS, AND ACADEMIA MAY BE CALLED FOR. BUSINESS-AS-USUAL MAY LEAD TO THE LOSS OF TECHNOLOGICAL LEADERSHIP AND THE U.S. MANUFACTURING BASE--BOTH PRE-REQUISITES TO ECONOMIC HEALTH AND STRONG NATIONAL SECURITY.

U.S. MANUFACTURING = JOBS

THE VALUE OF MANUFACTURING TO THE U.S. ECONOMY IS NOT ALWAYS WELL UNDERSTOOD. ECONOMISTS AND REPORTERS OF LABOR MARKET STATISTICS FREQUENTLY REPORT ONLY NUMBERS OF JOBS, NOT DIFFERENTIATING BETWEEN KINDS OF JOBS.

A SERVICE JOB, FOR EXAMPLE, IS HARDLY THE SAME AS A MANUFACTURING JOB. THE DIFFERENCES ARE MANY: HIGHER EDUCATION AND SKILLS ARE NEEDED TO BE AN ENGINEER COMPARED TO THOSE REQUIRED TO BE AN ASSEMBLER; AS TECHNOLOGY CHANGES JOB REQUIREMENTS, THE ENGINEER IS, THEREFORE, MORE READILY RE-TRAINABLE AND ADAPTABLE THAN THE ASSEMBLER. FURTHERMORE, THE ENGINEER IS A SUBSTANTIAL JOB CREATOR WHILE THE ASSEMBLER TENDS NOT TO BE: AN ENGINEER TYPICALLY

CREATES 8 SECONDARY AND 24 TERTIARY JOBS, WHEREAS ONE ASSEMBLER CREATES APPROXIMATELY 2 OTHER JOBS. IN ADDITION, THE ENGINEER WITH HIGHER WAGES TENDS TO MAKE A LARGER CONTRIBUTION TO THE U.S. TAX BASE COMPARED TO AN ASSEMBLER WITH MODEST, HOURLY PAY.

THE NEW NIST

THANKS IN LARGE PART TO THE LEADERSHIP OF YOU AND YOUR COMMITTEE, MR. CHAIRMAN, LAST YEAR CONGRESS RECOGNIZED AND RESPONDED TO THE NEED TO IMPROVE OUR MANUFACTURING BASE AND COMMERCIALIZATION SKILLS BY SIGNIFICANTLY ADDING TO THE NATIONAL BUREAU OF STANDARD'S CORE METROLOGY MISSION THE RESPONSIBILITY FOR IMPROVING QUALITY, MODERNIZING MANUFACTURING PROCESSES, AND FACILITATING THE TRANSFER AND COMMERCIALIZATION OF EMERGING TECHNOLOGIES. THIS ACTION IS STRONGLY SUPPORTED BY AEA.

UNFORTUNATELY, THE ADMINISTRATION HAS NOT YET PROPOSED TO AUGMENT THE NIST'S BUDGET TO FUND THESE NEW RESPONSIBILITIES. THE PROPOSED FUNDING FOR NIST BARELY KEEPS PACE WITH INFLATION, AND NO FUNDS HAVE BEEN PROVIDED FOR ITS NEW TECHNOLOGY TRANSFER FUNCTIONS.

THE COMMITTEE'S LEADERSHIP IS URGENTLY NEEDED TO PROVIDE A LONG-TERM PLAN, WITH APPROPRIATE INCREASES IN AUTHORIZATION AND APPROPRIATION, TO REDRESS NIST'S INABILITY TO KEEP PACE WITH BOTH THE GROWING NEED FOR PRECISION MEASUREMENTS AND FOR DEMONSTRABLE PROCESSES FOR IMPROVING THE TRANSFER OF TECHNOLOGY.

AEA APPLAUDS THE COMMITTEE'S SUCCESS IN ENACTING A FIVE-YEAR AUTHORIZATION FOR THE NATIONAL SCIENCE FOUNDATION AND SUPPORTING A DOUBLING OF THAT AGENCY'S BUDGET. WE URGE THE COMMITTEE TO RECOMMEND A COMPARABLE INVESTMENT IN NIST. IF THE U.S. GOVERNMENT WANTS TO ASSIST COMPANIES' ABILITIES TO TURN BASIC RESEARCH INTO QUALITY PRODUCTS, NIST IS THE RIGHT PLACE TO START.

COMPLEMENTARY TO THE NEED FOR CONGRESSIONAL LEADERSHIP IN SECURING RESOURCES FOR NIST TO CARRY OUT ITS NEW CHARTER IS THE NEED FOR EXECUTIVE LEADERSHIP. AEA STRONGLY URGES THE ADMINISTRATION TO EXPEDITIOUSLY NOMINATE FOR THE POSITIONS OF UNDERSECRETARY FOR TECHNOLOGY AND DIRECTOR OF NIST KNOWLEDGEABLE, EXPERIENCED INDIVIDUALS WHO WILL PROVIDE NOT ONLY NECESSARY MANAGEMENT SKILLS BUT CRITICAL LEADERSHIP CAPABILITIES. THESE TWO APPOINTMENTS MUST BE FILLED BY INDIVIDUALS WHO UNDERSTAND INDUSTRY'S NEEDS AND ARE WILLING TO AGGRESSIVELY PURSUE THEIR MISSIONS.

TECH TRANSFER KEY FOR ELECTRONICS

AEA STRONGLY DISAGREES WITH THE ADMINISTRATION'S INITIAL DECISION TO PROVIDE NO FUNDS IN FISCAL YEAR 1990 FOR NIST'S NEW TECHNOLOGY TRANSFER PROGRAMS: THE REGIONAL CENTERS FOR THE TRANSFER OF MANUFACTURING TECHNOLOGY; THE INDUSTRIAL EXTENSION SERVICES PROGRAM; THE ADVANCED TECHNOLOGY PROGRAM; AND THE CLEARINGHOUSE FOR STATE TECHNOLOGY PROGRAMS. THERE IS GROWING AWARENESS THAT

THE FEDERAL GOVERNMENT CAN PLAY AN IMPORTANT ROLE IN DEMONSTRATING INNOVATIONS IN MANUFACTURING PROCESS TECHNOLOGY TO ASSIST COMPANIES IN SPEEDIER, COST-EFFECTIVE PRODUCTION -- CRITICAL TO U.S. ABILITY TO REMAIN COMPETITIVE IN WORLD MARKETS. NIST'S NEW INITIATIVES ARE AN INNOVATIVE AND APPROPRIATE APPROACH TO IMPROVING TECHNOLOGY TRANSFER.

BECAUSE OF THE ELECTRONICS INDUSTRY'S LARGE MANUFACTURING BASE AND ITS ENTREPRENEURIAL NATURE, NIST'S TECHNOLOGY TRANSFER INITIATIVES ARE PARTICULARLY IMPORTANT.

ELECTRONICS IS AMERICA'S LARGEST MANUFACTURING INDUSTRY. OVER 2.6 MILLION AMERICAN WORKERS ARE DIRECTLY EMPLOYED IN ELECTRONICS MANUFACTURING. THIS IS THREE TIMES THE SIZE OF THE AUTO INDUSTRY AND NINE TIMES THAT OF THE STEEL INDUSTRY.

IN ADDITION, THE ELECTRONICS INDUSTRY IS ENTREPRENEURIAL IN NATURE. OVER HALF OF AEA'S 3,500 MEMBER COMPANIES ARE LESS THAN 10 YEARS OLD AND NEARLY THREE-QUARTERS ARE SMALL, EMPLOYING FEWER THAN 200 PEOPLE. PROGRAMS SUCH AS NIST'S REGIONAL CENTERS FOR THE TRANSFER OF MANUFACTURING TECHNOLOGY, WHICH ARE AIMED AT BRINGING MODERN MANUFACTURING TECHNOLOGY TO SMALL AND MID-SIZE FIRMS, COULD BE OF GREAT BENEFIT TO LARGE SEGMENTS OF THE ELECTRONICS INDUSTRY, PARTICULARLY IF SUCH CENTERS WERE DEVOTED TO STATE-OF-THE-ART AUTOMATED ELECTRONICS MANUFACTURING AND THE PROPER APPLICATION OF METROLOGY TO THE CONTROL OF QUALITY.

MOREOVER, WITH ADEQUATE SUPPORT, NIST'S ADVANCED TECHNOLOGY PROGRAM (ATP) COULD BE A VALUABLE TOOL FOR COORDINATING AND FINANCING THE FEDERAL GOVERNMENT'S PARTICIPATION IN INDUSTRY-LED CONSORTIA FOCUSED ON CRITICAL TECHNOLOGIES.

NIST AND ATV

ADVANCED TELEVISION (ATV, WHICH INCLUDES HDTV) HAS BEEN IDENTIFIED AS ONE OF THE CRITICAL EMERGING TECHNOLOGIES THAT WILL HAVE A SIGNIFICANT IMPACT ON THE LONG-TERM ECONOMIC HEALTH AND COMPETITIVENESS OF THE U.S. NIST, UNDER THE LEADERSHIP OF A NEW DIRECTOR AND OF THE NEW UNDERSECRETARY FOR TECHNOLOGY, COULD PLAY THE LEADING FEDERAL ROLE IN ASSISTING INDUSTRY WITH THE DEVELOPMENT AND COMMERCIALIZATION OF ADVANCED TELEVISION TECHNOLOGIES.

AEA APPLAUDS DARPA'S LEADERSHIP IN COMMITTING $30 MILLION FOR ATV-RELATED DEFENSE R&D. THE SHEER NUMBER OF ATV-RELATED PROPOSALS RECEIVED BY DARPA DEMONSTRATES THE EXTENT OF INDUSTRY INTEREST IN ATV AND THE ABILITY OF GOVERNMENT TO SERVE AS A CATALYST IN STIMULATING INDUSTRY ACTION. WITH THE NECESSARY FUNDS, NIST AND ITS ATP COULD SERVE AS THE CIVILIAN COUNTERPART TO DARPA, PROVIDING SUPPORT FOR INDUSTRIAL ATV TECHNOLOGY DEVELOPMENT AND THE BUILDING AND TESTING OF PROTOTYPE INTERCHANGE STANDARDS AND TRANSMISSION SYSTEMS.

WHAT IS HDTV?

AT ITS MOST BASIC LEVEL, ADVANCED TELEVISION IS A FUNDAMENTAL IMAGING TECHNOLOGY. WHILE THE FIRST ATV MARKETS WILL LIKELY BE IN THE ENTERTAINMENT FIELDS--BRINGING TO HOME TELEVISION WIDE-SCREEN PICTURES WITH THE SHARPNESS OF 35MM FILM AND DIGITAL STEREO SOUND--THE TECHNOLOGY SPIN-OFF MARKETS ARE MANY AND VARIED--MEDICAL IMAGING, TELECOMMUNICATIONS, PRINTING AND PUBLISHING, MILITARY AND SPACE, OFFICE AND INDUSTRIAL, AND PUBLIC (EDUCATION/AIR TRAFFIC CONTROL), ETC. AMONG THE END USE PRODUCTS WHICH SHARE SOME COMMON ATV TECHNOLOGY ARE COMPUTERS, SEMICONDUCTORS, LASER PRINTERS, DIGITAL COPIERS, INTELLIGENT WORK STATIONS, LASER FAX MACHINES, AND PERSONAL COMPUTERS, MEDICAL DIAGNOSTIC EQUIPMENT, ADVANCED AIRCRAFT CONTROL SYSTEMS, AND MILITARY COMMAND SYSTEMS AND MAPPING, TO NAME A FEW.

ATV, THUS, IS A TECHNOLOGY WITH LONG-TERM AND FAR-REACHING COMPETITIVE IMPLICATIONS. IT OFFERS THE U.S. A ONCE-IN-A-LIFETIME GATEWAY TO BOLSTER OUR PRESENT LEAD IN COMPUTERS AND TELECOMMUNICATIONS AS WELL AS POSITION US TO MANUFACTURE A VARIETY OF NEW END-USE MARKETS. NEW MARKET OPPORTUNITIES FROM ATV TECHNOLOGIES AND THEIR MANY SPIN-OFF PRODUCTS ARE EXPECTED CONSERVITELY TO TOTAL $20 BILLION BY THE YEAR 2000.

OUR POSITION AMONG THE WORLD'S THREE MAJOR ECONOMIES IS ALREADY THREATENED BY A CONTINUAL EROSION OF COMPETITIVENESS IN STRATEGIC ELECTRONICS TECHNOLOGIES. MUCH OF THE LOSS OF THE U.S.

ELECTRONICS INDUSTRY'S GLOBAL MARKET SHARE CAN BE TRACED TO THE INDUSTRY'S DEPARTURE FROM THE CONSUMER MARKET IN THE EARLY 1970'S. LOSS OF CONSUMER ELECTRONICS NOW ACCOUNTS FOR ABOUT $7 BILLION OR ONE-THIRD OF OUR ELECTRONICS TRADE DEFICIT WITH JAPAN. TYPICALLY, EACH $1 BILLION IN TRADE DEFICIT TRANSLATES INTO 12,000 LOST JOBS.

FAILURE OF THE U.S. TO GO THROUGH THE ATV GATEWAY, HOWEVER, HAS A SIGNIFICANT DOWNSIDE. SERIOUS MARKET EROSION CAN BE EXPECTED IN ALMOST EVERY NON-CONSUMER U.S. ELECTRONICS SEGMENT -- SEMICONDUCTORS, TELECOMMUNICATIONS, COMPUTERS, ETC. FOREIGN MANUFACTURERS WILL GAIN ADVANTAGE IN TECHNOLOGICAL KNOW-HOW OF SEMICONDUCTORS AND, THEREFORE, KEY STEPPING STONES TO DOMINATE MANY ELECTRONIC MARKETS, INCLUDING COMPUTERS. FURTHERMORE, THE MEMORY CAPACITY OF HDTV SETS WILL GIVE THE MANUFACTURER A VITAL EDGE AS PRODUCTS EVOLVE INTO COMPUTERS, HOME "MARKETING MACHINES," ETC.

UNLESS THE U.S. PARTICIPATES IN THE LOW-END, LOW-RETURN TELEVISION INDUSTRY IN THE 1990'S, WE WILL BE CLOSED OUT OF THE HIGH-END, HIGH-RETURN SPIN OFF MARKETS IN THE YEAR 2000 AND BEYOND.

VERTICALLY INTEGRATED JAPANESE COMPANIES, SOME WITH GOVERNMENT ASSISTANCE, ALL WITH SIGNIFICANTLY LOWER CAPITAL COSTS HAVE DECIDED ADVANTAGE OVER THE U.S. THEY NOT ONLY HAVE THE

MANUFACTURING, DISTRIBUTING, AND MARKETING INFRASTRUCTURE BUT THEY CAN SUSTAIN LOW RETURNS IN THE ATV MARKETS OVER MANY YEARS BY OFFSETTING LOSSES WITH MORE PROFITABLE PRODUCT LINES--SUCH AS VCRs.

FOREIGN ATV DOMINANCE = GREATER FOREIGN SEMICONDUCTOR DEPENDENCY

ATV ALSO OFFERS FOREIGN COMPANIES A PATHWAY TO THE U.S. NON-CONSUMER ELECTRONICS MARKET, WHICH HAS SERIOUS ECONOMIC AND DEFENSE IMPLICATIONS. FOR EXAMPLE, ATV'S WILL CONSUME LARGE QUANTITIES OF SEMICONDUCTORS, SIMILAR TO THE TYPE NEEDED IN TOMORROW'S ADVANCED COMPUTERS. IF, THROUGH ATV, THIS TECHNOLOGY FLOURISHES ELSEWHERE, WE MAY BECOME DEPENDENT ON A FOREIGN SOURCE FOR THESE IMPORTANT CHIPS.

A STRATEGY FOR THE U.S.

THE AEA ATV BUSINESS PLAN GROUP (COMPRISED OF 36 AEA MEMBER COMPANIES) CONTRACTED WITH THE BOSTON CONSULTING GROUP (BCG) TO IDENTIFY A STRATEGY FOR PARTICIPATION BY THE U.S. ECONOMY IN ATV AND ITS PRODUCT SPINOFFS. THIS PLAN IS OFFERED AS A STARTING POINT FOR THE DEBATE OVER AMERICA'S INVOLVEMENT IN ATV TECHNOLOGIES.

THE BCG FOUND THAT BECAUSE OF THE SIZE OF INVESTMENT REQUIRED, THE ANTICIPATED MODEST RETURNS UNTIL SOME FIVE TO SEVEN YEARS OUT, THE TIME AND RISK TAKING NEEDED TO DEVELOP THE MARKET, AND THE FACT THAT JAPAN AND EUROPE ARE SO FAR AHEAD IN ATV

TECHNOLOGIES, MOST U.S. ELECTRONICS FIRMS ARE RELUCTANT TO PARTICIPATE EITHER INDIVIDUALLY OR AS PART OF A COLLECTION OF COMPANIES WITHOUT SERIOUS FINANCIAL RISK REDUCTION. BCG REPORTED, HOWEVER, THAT WITH A DECISIVE, INDUSTRY-LED, JOINT INDUSTRY-GOVERNMENT SUPPORTED STRATEGY, THE U.S. COULD BUILD A STRONG BASE IN ATV AND OTHER HIGH-DEFINITION PRODUCTS AND COMPONENTS.

THE BCG'S STRATEGY FOR DEVELOPING A SIGNIFICANT NEW U.S. PRESENCE IN ATV MARKETS INCLUDES:

- PLUGGING HOLES IN THE U.S. TECHNOLOGY BASE;

- PURSUING BREAKTHROUGH INNOVATIONS;

- BUILDING WORLD-CLASS MANUFACTURING, COMPONENT, AND DESIGN INFRASTRUCTURE;

- SELECTING AND ADMINISTRERING STANDARDS IN A WAY THAT FOSTERS DEVELOPMENT OF A STRONG U.S.-BASED ATV INDUSTRY;

- MAKING LOWER-COST CAPITAL AVAILABLE FOR MANUFACTURING; AND

- INVESTING IN "PUMP-PRIMING" TO BOOST PROGRAMMING (SOFTWARE) AVAILABILITY LEADING TO CREATION OF A SUBSTANTIAL CONSUMER BASE.

SPECIFICALLY, BCG RECOMMENDED THAT, TO OVERCOME SUCH BARRIERS TO U.S. PARTICIPATION AS HIGHER CAPITAL COSTS AND THE INABILITY OF COMPANIES TO SUSTAIN LOW MARGINS OF RETURN, AN INDUSTRY-GOVERNMENT PARTNERSHIP PROCESS BE UNDERTAKEN. IT IS SUGGESTED THAT THIS PROCESS INCLUDE THE FOLLOWING ACTIONS:

- ENCOURAGE INVESTMENT BY MAKING PERMANENT THE R&D TAX CREDIT AND LOWERING THE CAPITAL GAINS TAX.

- MAKE RECOMMENDATIONS TO THE FEDERAL GOVERNMENT FOR CHANGES IN ANTI-TRUST LAWS TO PERMIT JOINT ATV MANUFACTURING AND MARKETING;

- CREATE AN INDUSTRY-LED ADVISORY ENTITY (REFERRED TO IN THE BCG REPORT AS "ATV CORP."), COMPRISED OF MEMBERS FROM INDUSTRY, GOVERNMENT, AND ACADEMIA, TO MONITOR AND GUIDE DEVELOPMENT OF A U.S. ATV TECHNOLOGIES INDUSTRY (E.G. ENSURE R&D TECHNOLOGY GRANTS MEET COMMERCIAL NEEDS, MONITOR ENFORCEMENT OF ANTI-DUMPING REGULATIONS, EXECUTE "PUMP PRIMING" PROGRAMS TO ENCOURAGE DEVELOPMENT OF CONSUMER MARKETS)

- USE STANDARDS TO ENCOURAGE: U.S.-BASED R&D, DESIGN, AND MANUFACTURING; USE OF U.S. SEMICONDUCTOR CHIPS; AND RECIPROCAL ACCESS BY U.S. OF ATV-RELATED MARKETS IN OTHER COUNTRIES;

- UNDERTAKE ATV TECHNOLOGY DEVELOPMENT -- WITH A MINIMUM OF DOLLAR-FOR DOLLAR INDUSTRY CO-INVESTMENT -- THROUGH THE DEFENSE DEPARTMENT'S (DARPA) R&D GRANTS AT A LEVEL OF $100 MILLION A YEAR FOR THREE YEARS;

- UNDERTAKE DEVELOPMENT OF PROTOTYPE TRANSMISSION STANDARDS SYSTEM, AND PROTOTYPE DESIGN AND MANUFACTURING PROCESS TECHNOLOGY -- WITH SUBSTANTIAL INDUSTRY CO-INVESTMENT -- THROUGH THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) AT A LEVEL OF AT LEAST $17 MILLION A YEAR FOR THREE YEARS;

- BECAUSE OF THE HIGH COST OF CAPITAL AVAILABLE TO U.S. COMPANIES, SUPPLY LOW COST LOANS AND LOAN GUARANTEES IN THE "OUT YEARS" TO HELP BUILD MANUFACTURING INFRASTRUCTURE AND PRODUCTION OF ATV PRODUCTS AND SUPPORT WORKING CAPTIAL NEEDS.

THE ATTACHED EXCERPT FROM THE BCG REPORT PROVIDES A DETAILED SUMMARY OF THE PROPOSED INDUSTRY/GOVERNMENT PARTNERSHIP TO FOSTER DEVELOPMENT OF A U.S.-BASED ATV INDUSTRY.

GIVEN ADEQUATE APPROPRIATIONS, NIST CAN PLAY A KEY ROLE IN HELPING THE U.S. KEEP ITS TECHNOLOGICAL AND MANUFACTURING BASE. IT CAN SERVE AS A CORNERSTONE TO PROMOTE THE DEVELOPMENT OF LEADING EDGE TECHNOLOGIES AND THEIR COMMERCIALIZATION.

INDUSTRY/GOVERNMENT PARTNERSHIP:

POLICIES TO FOSTER DEVELOPMENT OF AN ATV INDUSTRY

The following government actions are needed to carry out the government and industry roles in development of a U. S.-based ATV industry.

1. The U. S. Congress should charter a corporation ("ATV Corporation") to guide the development of the U. S. ATV industry. The role of ATV Corporation is to:

   - Guide the development of the U. S. ATV industry, recommending government assistance where needed.
   - Own and license (or exclusively license and sub-license) the technology underlying the broadcast standard to producers of ATV hardware, and reinvest the royalty income in development of the U. S. technology base and manufacturing capability for ATVs and related high definition imaging products.
   - Provide and administer low-cost government loans and loan guarantees to U. S.-based ATV producers
   - Develop an ATV R&D plan to guide the programs of the government agencies that will be funding ATV-related research (e.g., DARPA).
   - Establish cost-sharing guidelines for industry participation in the loan and R&D funding programs.
   - Monitor industry development and promptly identify apparent dumping problems.
   - Execute a program to stimulate development of the market for ATV hardware, transmission services, and software.

ATV Corporation will be managed by a board of directors appointed by the President and the Congress, and representing government, industry, and academia. The chairman of the board and a majority of members should be from industry. In the future, after government loans and guarantees have been retired, ATV Corporation may become a private company by selling its shares to the public and using its technology and royalty revenues to develop, produce, and market ATV-related products.

The U.S. Congress should authorize DOC NIST
to provide loan guarantees of up to $500 million and direct loans of up to $500 million to U. S.-based ATV industry participants via ATV Corporation. The purpose of these loans is to attract participation by U.S. industry in the ATV market, to enable investments to develop a world-class industrial infrastructure for ATV and AVCR manufacture in the U. S., and to provide working capital assistance to new U.S.-based entrants into the ATV market.

(U. S.-headquartered industry has largely withdrawn from the TV market, and successful electronics companies decline to enter, for the explicitly stated reason

that the ROI available is below cost of capital. And, the U. S. lacks low-cost, highly-automated complexes combining management, engineering, and manufacturing of high-value-added video products such as the Matsushita complex at Kadoma, Japan or the Mitsubishi complex at Nagaokakyo, Japan. And, launching the ATV market in the U.S. requires long time horizons, as large investments must be made in the 1990s, but substantial profits will not be enjoyed before the next decade. To create a competitive manufacturing infrastructure for ATV products in the U. S. and avoid further job export, a substatial injection of low-cost capital is needed. Once a world class infrastructure is in place, U. S. firms will be able to compete effectively, earn reasonable returns on additional investments, and leverage their infrastructure to produce related products such as workstation displays and CPUs.)

The interest rates and permitted leverage ratios for these loans should depend on the level of commitment to product and infrastructure development of the company receiving the loans — loans for incremental improvements (new machinery in existing facilities) should be smaller and closer to market rates, while loans for new, fully integrated complexes similar to those in Japan would be larger with lower rates. In any case, ATV Corporation will require significant risk sharing and co-investment by the company receiving the loan. To qualify for loans or guarantees an entity must:

a. Use the loaned funds, together with corporate funds, to construct world-class industrial infrastructure for ATV products.

b. Perform the majority of its relevant R&D, product and manufacturing systems design and engineering, and manufacturing in the U.S.

c. Purchase the majority of its semiconductors from firms based in the U.S.

We expect that the companies receiving these loans will be of several types:

a. Existing producers of video products and components (e.g., CRTs, ICs) wishing to upgrade their facilities, expand capacity, enter new product areas (e.g., Advanced VCRs), and/or develop a new site to produce ATV products.

b. Joint venture companies formed to produce ATV products and components (in some cases joint ventures with foreign companies will be desirable), such as Zenith/ATT, and needing to create or upgrade manufacturing capability.

c. A new, independent company formed as a pooled investment of technology and financial resources (e.g., the RCA model).

d. Small, entrepreneurial companies focusing on ATV products.

2. The Administration should request and the U.S. Congress should authorize and appropriate $100 million each year over three years beginning in FY 90 to DoD (specifically to DARPA), to continue its current research programs in high definition technologies.

(Preliminary indications from reviews by DARPA of the over 80 proposals it received from industry indicate that many promising technology concepts exist in the U. S. The level of investment in development of these concepts into full-scale, producible products is much lower in the U. S., however, than in Europe and especially Japan. This additional funding is needed to promote additional R&D for ATV-related technologies at a level competitive with other areas of the world. We recommend that DARPA pursue its current strategy of encouraging companies that receive contract awards for R&D to join together in appropriate groups, which may form the core of fully integrated companies developing and producing ATV-related products.)

3. The Administration should request and the U.S. Congress should authorize and appropriate a minimum of $50 million over three years to the Department of Commerce to develop standards for ATV production and transmission, investigate and demonstrate flexible manufacturing technologies, and fund the start up of the new NIST-based Technology Foundation established in the 1988 Omnibus Trade and Competitiveness Act. Part of this money should be used to finance prototype construction and testing for broadcast standards, in order to make possible testing of all high-potential candidate standards.

4. NIST, in close cooperation with the FCC, should develop high definition interchange and broadcast standards in close coordination with U.S. industry and the ATSC and recommend them to the FCC, NTIA and the Congress for consideration and adoption. The NIST should develop a basic interchange standard for high definition programs and software to facilitate exchange of material with low cost and high quality among various production sources, transmission media, and regional broadcast standards (e.g., MUSE and MAC). In developing and recommending standards, the NIST should have an explicit objective of enhancing the economic fortunes of the U.S.-based ATV industry.

   The following criteria should apply to the selection of a broadcast standard. The standard chosen should:

   a. Accommodate the various delivery media of broadcast transmission (terrestrial and satellite), closed transmission (cable and fiber optics), and physical (cassette and optical disc).

   b. Have a high level of compatibility with the interchange standard, and with fully digital transmission techniques that will be widespread in the future.

   c. Be compatible with existing NTSC receivers; specifically, ATVs should be able to receive the NTSC signal, and signals receivable by existing NTSC sets should be transmitted for a long period after commencement of HD broadcasting. It is also desirable that AVCRs be able to play both NTSC and HD cassettes, output a very high quality NTSC-usable signal from an HD videotape, and (more difficult) that HD cassettes be playable on VHS VCRs.

   d. Provide a high-quality picture (in terms of aspect ratio, spatial and temporal resolution, multi-channel high-fidelity sound, absence of artifacts, transmission robustness, etc.) which will promote rapid penetration of ATV equipment into

U. S. households and give maximum impetus to the U. S. electronic technology base.

e. Be technically compatible with digital imaging techniques (e.g., square pixels) used in allied industries, such as engineering graphics, medical imaging, and electronic publishing, in order to maximize production economies and technology interchanges.

f. Promote U.S.-based industry participation in non-U.S. markets for ATV equipment by facilitating adaptation of U. S. equipment to foreign signal encoding and transmission standards, thereby allowing U.S.-based industry to develop economies of scale through participation in world markets.

g. Be spectrum efficient and non-interfering.

5. The DOC Patent and Trademark Office and the U.S. Copyright office in conjunction with the appropriate Judiciary subcommittees of the U.S. Congress should design and adopt a method by which NIST's recommended standards, if adopted by the FCC and the Congress, could be owned as intellectual property or licensed exclusively by the U.S. or the ATV Corporation for the benefit of the U. S. The originator of the standard should receive fair compensation for its investment and risk taking.

   The DOC Technology Administration should develop a method to license prospective domestic and foreign equipment manufacturers. Revenues from royalties and licensing fees should be used to fund continued investment in activities designed to maximize participation by the U.S. economy in the ATV and high definition imaging industries.

   Licensing fee schedules, royalty-funded investments, direct R&D grants, and/or other economic incentives to ATV producers (e.g., tax benefits) should be based on:

   a. The amount of R&D, product design and manufacturing presence in the U.S.

   b. The amount of domestically designed and fabricated integrated circuits in any equipment that utilizes the standards to be licensed.

   c. The extent to which U.S.-based firms have access on reciprocal terms to the ATV market in the home countries of prospective non-U.S. based licensees.

   The DOC should ensure that any such approach takes account of U. S. obligations under GATT.

6. The NIST manufacturing support centers should be tasked by the DOC and the Congress to identify, develop through the private sector, and to demonstrate appropriate flexible manufacturing systems that could be adopted by prospective U.S.-based entrants into the ATV business.

7. The U.S. Congress should authorize the DOC to organize a program to be executed by ATV Corporation to develop and demonstrate ATV products and to encourage purchase

of ATV hardware and development and distribution of ATV programming. Without such a program, the "chicken-and-egg" problem of lack-of-programming/lack-of-hardware will slow development of the market. Key elements of this program should be:

a. Technical and financial assistance to promote early development and distribution of high-definition software (programming material and videocassettes).

b. Technical and financial assistance to assist with development of experimental and showcase applications of ATV hardware (e.g., at trade shows and expositions).

8. The FCC, the DOC NTIA, and the U.S. Congress should take steps to encourage a national policy environment that fosters expedited market-driven installation of fiber optic cable, especially to individual residences, in the context of multi-media broadcasting infrastructure. A high-bandwidth, interactive delivery system to the home and to business will have a strong, positive effect on demand for high-capacity digital terminal products of all kinds, particularly ATVs. It will have a similar effect on demand for software and services that employ the high bandwidth network. Creating such a large demand for high-technology products early in the U. S. will benefit the technology base and manufacturing infrastructure of the U. S. industry, particularly if parallel steps are taken to strengthen the capability to develop and produce these products in the U. S.

9. The U.S. Congress should authorize the DOT and FAA to sponsor research to develop a U. S. source for the follow-on display technology for the FAA Air Traffic Control System, both to ensure that a domestic source exists and to ensure that the collateral benefits of this technology investment are enjoyed by the U. S. high definition imaging industry.

10. The DOJ should recommend to the U.S. Congress any changes required in U.S. antitrust laws which would inhibit the full participation of the U.S. economy in the ATV market.

11. The USTR should include in its discussions with other countries in the context of GATT and the requirements of the new omnibus trade law the necessity of fair, equitable, and reciprocal access to ATV-related markets.

12. The FCC and appropriate Congressional committees should design incentives for broadcasters to invest in ATV studio and transmission equipment, such as an extended license term for broadcasters making the investment.

The CHAIRMAN. Mr. Miller.

STATEMENT OF EDWARD A. MILLER, PRESIDENT, NATIONAL CENTER FOR MANUFACTURING SCIENCES

Mr. MILLER. Mr. Chairman and distinguished members, I am extremely pleased to be here on behalf of the National Center for Manufacturing Sciences.

Since this is my first time coming before you, I will tell you that I am the president and CEO of the National Center for Manufacturing Sciences. I am an engineer and very proud of it. I have spent 25 years of my career on the factory floor, working with manufacturing technology, and so I am quite well aware of it.

I would like to talk briefly about a paradigm that you started your discussion on earlier. It is the paradigm that our foreign trading partners are using very effectively now, one of cooperation. It is a lesson that we are looking at; one that they have put a lot of time and effort in. And it is one that is very different from the way we conduct business in the United States.

I would like to talk in particular about the paradigm in Japan, because it is probably the best one on cooperation that exists in the world. Everybody talks about corporation in the industrial market, what we see at the Ministry of International Trade and Industry, or maybe at the Ministry of Labor, but there is quite a bit more. It is also done at the Ministry of Finance.

I would like to discuss one of their programs the fiscal incentive and loan program. It is an off-balance sheet program in the Japanese government. Last year, according to the Office of Technology Assessment, it was funded off the balance sheet at $31 trillion yen i.e. over $200 billion at today's exchange rates.

That is quite a bit of money to have to invest and to cooperate with society on. The Ministry uses this money very effectively in partnerships at all levels of government. They use it throughout the national level. They use it at the prefecture level, in prefectures like Kanagawa. They use it at the city level in cities like Tokyo. They even use it at sub-city levels in the wards, like Ota.

We have had an opportunity to visit and to talk to their people—our membership. We have about 100 companies involved in the National Center for Manufacturing Sciences. Some 1,200 or 1,300 of those executives have had opportunities to look at the cooperate paradigm that is working in Japan, and understand the benefits of what they have done and the extent of what they have done.

Some of the Ministry of Finance programs do not go for just finance, they tie knowledge, knowhow, technology and financial programs together quite adequately. They do not just lend out money for the sake of lending out money. And they do not necessarily just pick winners.

They do have a strategy that attempts to direct and develop a consensus along some industrial lines where they have determined that markets are beneficial. But they also look at other opportunities that are industry driven that are brought back to the government and put in front of them. Some of those programs were mentioned earlier today. The Key Technology Program is one of those that is being nucleated now in that regard.

The one point that I would like to make about this cooperative paradigm is that it is very well networked together; that if you get involved at a national level with the Ministry of Finance or MITI or any of the other ministries, for that matter, you are almost automatically involved at the prefecture levels, the city levels and the ward levels.

These are not programs that are unlike what we do in the United States, but they are much broader in perspective and much more effective. All of their industries are aware of what they do and what they are willing to cooperate on. There is a much higher degree of trust between industry and government than exists in the United States.

I do not want to dwell on the paradigm; I really would like to move on to the National Center for Manufacturing Sciences, and for a particular reason.

We were formed under the National Cooperative Research Act of 1984, predominantly because of the declining capabilities or competitiveness of our manufacturing industries to undertake research on manufacturing technology.

We looked at what we learned and how far our foreign trading partners have progressed. We established an organization and we have put together what I think is a very good R&D program on manufacturing technology, based on what we saw our foreign trading partners doing.

Mr. Chairman, I would like to offer you a copy of a report out of Japan on what their R&D technologies are. It is quite broad based. And the original untranslated document is about 1,000 pages long. I am unaware of anything in the United States where we have put comparable effort into defining the technologies that may be important to our country in the future.

In my written testimony I entered a description of our R&D agenda. I would rather pass by that and talk to you about what I think the most important lesson is that we have learned in the National Center for Manufacturing Sciences. It does not have anything to do with technology; it really is that we have learned to cooperate in our organization. I say this because from the day every one of us are born, we are taught to be individuals; we are rewarded as individuals from the time we start in school, from learning our ABCs or learning our math. I know that we are rewarded for chemistry lab experiments as individuals, for theses that we write, or after we get out of school; in industry we are rewarded as individuals; we are never taught to cooperate.

And so, when you bring a group of 1,200 executives together and say, "Hey, guys, we have changed the rules. It is time to cooperate." It is not that easy. You have to sit down and tear down the barriers that you have built up all of your career and learn what cooperation is all about. You must learn it more than from a lip service basis; which is what I think is done in most cases around the United States now. We say we are going to cooperate together, but we do not put our heart and soul and our trust in it.

In the National Center for Manufacturing Sciences we determined that we were going to tear down those barriers and we were going to learn what cooperation was about. If it was something that our trading partners could do, we felt that they were no better and no worse than we were. We could learn the lessons also.

It took us a couple of years, and I think if there is another industrial consortia that goes into place, whether it is on HDTV or it is on some other important technology, give them time to mature and to grow, because they are going to have to learn what it takes to put forth all of their best people, all of their best efforts, learn where they have to have secrets and learn where they can share the secrets.

You are going to find, as we have, that we have gained much more cooperation than from competition; much more from sharing our energies and intellectual properties than from hiding them.

In that regard, this kind of leads me to the last thing that I would like to talk about. I really would like to congratulate Congress for what they did when they put the technology programs of the Department of Commerce in place.

We studied what it would take to transfer technology, and one of the things that we concluded, and I will happy to give you a copy of that report also, Mr. Chairman, is that technology transfer is a body contact support.

It is not sending out a bunch of reports that collect dust on shelves. The way that you get that body contact support up is by having some technical assistance programs. And lots of technology centers, having a broad network. Not necessarily what they have in Japan, but comparable to what we have in the United States but with more strength and market-driven, industry-led.

In that regard, the centers should be feeding industry the kinds of information and technologies and assistance they need. I might add that it does not necessarily have to be only technology. The Japanese provide support on planning, budget, management, quality control, technology, finance, and other activities.

We do not have a paradigm in the United States that can help business on all of the needs that they have. That is one of the things we have got to do. You cannot solve the problems solely with technology.

I would like to tell you that you have not started the Advanced Technology Program. That is another good program that I think it offers an excellent opportunity. I would like to see, this year, Congress get into funding that program and providing monies and the time and the effort to have that program work.

I am biased. I think that one of the critical technologies that would benefit from a program in that area happens to be in the area that we are working on, manufacturing technology, something that would help restore numerous industries to competitive strength.

I think when you are looking at the budgets, maybe you can provide substantial, long term funding in that regard.

I would like to leave you with one thought, because it came up earlier. I do not want to see Congress bail out losers. But, by the same token, I do not want to see Congress pick winners. What I would like to see is Congress invest, Congress create winners, create the environment where ideas can be nurtured, where companies can grow, where industries can prosper and strengthen.

I think that that is the key to restoring our competitive strength. I do not think you have to pick winners. I think you can create them if you create the environment.

Thank you, Mr. Chairman.

[The statement follows:]

Testimony of

Edward A. Miller

President

National Center for Manufacturing Sciences

Mr. Chairman, and distinguished members of the United States Senate Committee on Commerce, Science, and Transportation.

I am Edward A. Miller, President and CEO of the National Center for Manufacturing Sciences (NCMS). By education I am an engineer, and by training I have spent more than a quarter of a century in work activities in manufacturing and directly associated with technology on the factory floor.

On behalf of the National Center for Manufacturing Sciences, I am extremely pleased to have this opportunity to address you today on industry's perspectives, on an industrial consortia's perspective of our nation's critical technology base and its implications for our industrial competitiveness in a global economy. I would like to accomplish this by examining three topical areas.

1. The Paradigm of Cooperation within One of Our Trading Partners.
2. The National Center for Manufacturing Sciences and the Partnership it has Established, and
3. The Role of the Technology Programs of the Department of Commerce.

Let me begin by stating that I assume numerous corporate executives, industry and government experts, as well as academic and labor leaders have come before you and your colleagues to inform you of the competitiveness dilemma faced in this nation by industry. I do not wish to repeat what they may have told you or to discuss the many practices employed by our trading partners which have exacerbated the situation at the very least.

I do agree that most U.S. industries are no longer competitive on a global basis and that many of our companies have been weakened to such an extent that they are hard pressed to deal effectively in international markets. Instead, I wish to use the time that you have so generously provided to me to discuss one of the important lessons that we have learned. It is a lesson that bears particular relevance on today's hearings and on the paradigm of tomorrow's industrial world. It is a lesson on cooperation.

Although similar examples can be provided concerning many of our trading partners, I would like to restrict my remarks to one country, to Japan. It provides an excellent example and has, in fact, set a model for the world that is being emulated by many other countries. To further facilitate my example, I want to restrict my discussion to information and technology including three subtopics, its R&D, utilization and finance.

After World War II, the Japanese recognized the long-term nature of restoring their country and strength to their industries. The first part of our first lesson is that it took three to four decades to accomplish. Crucial to their success was the understanding by both industry and government of the importance of the roles of knowledge and capital. Both are required for success, are usually provided together and are difficult or even impossible to discuss separately.

Japan has many programs that deal with knowledge and capital. In addition to the interrelationships at a national level, the system is integrated vertically through the prefectures, cities and wards a well as both the public and private sectors. A good starting place is the Ministry of Finance (Okurashoo). Recent reports suggest that the Ministry of Finance may be the single most powerful organization in the world. It controls the assets of the Japanese Postal System, which is close to a trillion dollars, making it larger than the top 12 U.S. banks combined. Further, it receives monies from employees and national pensions, NTT dividends and equity sales, tobacco dividends, and profits from the Japan Development Bank and the Import Export Bank. These funds, which are commonly referred to as the "second budget", are not part of the General Account Budget of Japan.

Within the Ministry of Finance I would like to focus on one program, the Fiscal Incentive and Loan Program. In the 50s, 60s and 70s this program was used to channel scarce capital into large organizations to enable them to increase their international competitiveness. Picking winners. If we looked at the 50 largest organizations in the world, 70 percent are Japanese and 20 percent are U.S. Since many of these organizations are now financial fortresses and capital is more readily available, their focus has changed to medium and small size firms. The most recent data that I have seen indicates that this program was funded at approximately 31 trillion yen in 1988.

In addition to its powerful effect on areas such as mergers and acquisitions, stable share holding, tax law, macroeconomic and fiscal policy, it has many tools to channel funds, knowledge and expertise to specific industries and companies. Since innovation is one of their major focuses, a considerable portion of their funding activities are directed at R&D efforts. In this regard, their lending tends to trigger capital availability and lending by other financial institutions, city banks, insurance companies, etc. to the same industries and companies. On a macrobasis, the tendency is to create an environment which fosters the development, growth and strengthening of individual companies and entire industries.

Closely associated, at least from a goals perspective, is the Ministry of International Trade and Industry (MITI). And in particular, its Small and Medium Enterprise Institute. Like the Ministry of Finance, it has a wide range of tools to channel funds, knowledge and expertise to specific industries and companies. In fact, the enterprise programs as originally envisioned, viewed the need for knowledge greater than the need for capital. In any event, both are provided directly and indirectly to individual companies and "associations" of companies. For the latter, companies, particularly small companies are encouraged to form or join associations with both similar and different type organizations.

The Japanese Government and financial institutions encourage this because of their belief that sharing scarce or seldom used resources, accounting facilities, capital, research, etc., contribute procompetitively to better and stronger companies. In addition, information, knowledge and expertise are exchanged more readily while the entire association tends to assist individual companies through difficult periods.

MITI continues to play a very strong role in the R&D of Japanese industry. First, every couple of years MITI facilitates the updating of a national R&D document. This document or game plan is developed by a team of over a thousand scientists, engineers and leaders from industry, academia and government. It establishes a national perspective for needed R&D that has the general consensus of the country. Individual companies, universities and government then undertake the identified R&D topics, sometimes with the encouragement of MITI, sometimes without it. Mr. Chairman, because this R&D game plan is so extensive, I would like to present you with a translated copy of the summary.

While a significant amount of support is provided directly to individual organizations, an equally large, perhaps even larger amount is provided indirectly and through a system of local entities. At NCMS, we have tried to look at all levels to gain an understanding of the role and effectiveness. At the prefecture level, one that we have been exposed to is the Kanagawa Prefecture. They maintain very close ties with the Ministries and operate a variety of programs.

Kanagawa developed a business plan some years ago. It was designed to nucleate and promote certain types of businesses. The emphasis was on electronics, industrial goods, video equipment, display technology, large appliances, integrated circuits, software, and assembly systems and machine tools. Kanagawa uses its position and role to develop and channel funds and knowledge to companies in or interested in these industries. They also support other industries if an analysis demonstrates a worthwhile opportunity.

To provide the level of technical expertise necessary to support these industries in addition to their in-house staff, they draw upon the Technology Experimental Center in Tokyo. Nearly 400 experts in business, finance, marketing and a wide range of R&D and manufacturing skills are available. Some of their services are in their offices, while others are performed at the company site. The costs for their services vary between free and nominal. Every organization requesting funds, loans or other assistance is required to undergo a thorough business "checkup". This checkup process is usually the beginning of a partnership that lasts for decades.

Kanagawa has also established a Science Park which provides common research facilities. It presently has the dual function of also serving as a business incubator. This basically means that many common services are available in addition to laboratory facilities and equipment. Because they understand the implications of marketing, they are expanding the park to include hotels, restaurants, banks, etc.

Kanagawa takes a strong interest in the formation of industry associations. Of particular interest are the "inter-industry exchange groups". Established predominantly to share information, research and technology resources, Kanagawa channels money and knowledge directly to the association. This makes all of the groups' members responsible for the money, thereby promoting mutual support. Kanagawa is typical of prefecture level support provided to industry.

Below the prefectures, in the cities, and for large cities in the wards, an even greater degree of hands-on assistance and support are provided. This includes business planning, financial, work force training, technology introduction, technology modifications and equipment adaptation, favorable tax treatment, marketing and sales support, production and technology demonstrations, to mention a few. Although there is considerable variation between the type and level of support at the city and ward level, the point to remember is that the support is there, that it is a broad network and that industry is aware of it and makes use of it.

The relationship between the Japanese Government at all levels and industry has taken on a symbiotic nature. When a company or an association and the government establish a relationship, it becomes a long-term partnership. A true partnership with a high degree of trust and a focus on long-term goals (usually increased market share). It is quite different from the adversarial roles that industry and government have assumed in the United States.

Let me move on the second item that I wish to discuss, the National Center for Manufacturing Sciences. The NCMS was established as a result of a recognition by government and industry that one of the causes in the declining competitiveness of U.S. manufacturing industries was manufacturing technology. We laid out an organization, incorporated it and filed for protection under the National Cooperative Research Act of 1984 to undertake research on manufacturing technology.

There were many, many individuals involved in the startup of NCMS, but I had the unique privilege of being selected as the first President. As a result, I have had a very special vantage point to watch an unprecedented piece of history unfold. Before I tell you about it, I want to set the stage for what I will say.

I am sure that all of us in this room grew up under similar conditions, so I will tap my personal background. When I entered school as a child, I soon learned that our reward system is biased towards individualism. I was rewarded for my penmanship, for learning my ABCs, for counting and for drawing pictures. As I progressed through school, my English composition, my short stories, my chemistry lab experiments earned me a pat on the back. In college, it was more of the same, individual achievements and individual awards. It does not stop there, either.

Whether it is a Pulitzer or a Nobel prize or something else, every day we hear the virtues of being an individual.

It is not surprising then that when you bring a room full of industries' best executives together and say "Let's cooperate", that we do not really know how. Yes, we said that we would cooperate right from the beginning, but we did not even understand then that we did not know how. It is something that we had to learn and we did. We learned that we have erected a multitude of barriers, some of them token, some of them structural and some of them physical. It is the me and you, the us and them syndrome.

We began to realize early along that these barriers were there and would impede our success. We decided to identify them and to tear each one down. I will give you one example of a symbolic barrier. On the name badges that we use at meetings, we eliminated company names and titles. Everyone is a "Member" of NCMS, there is no us and them at work. As this began to happen, we began to learn about cooperation, not skin-deep cooperation, but real cooperation. The kind of cooperation you expect when your survival is on the line. Although we believe that amongst industry we know what cooperation is about, we also know that we have not mastered it between industry and government beyond a superficial understanding.

When we set our first research agenda, much of it dealt with items that we all indicated were important. However, they would not provide a competitive advantage to anyone. They were good programs, but most large companies had already undertaken them, completed the R&D and put them into practice. Today, our members recognize that what they thought they were guarding in their shops, everyone else was also guarding. As a result, our R&D agenda has taken on a much more strategic perspective. Every one of our members knows that they will have the same level of manufacturing technology available to their companies. So where is the advantage? It is in the product technology that they will produce and sell to consumers. If they do not use the best world class manufacturing technology, they lose. If they use it, they must win with their products.

Let me take a minute to give you a brief overview of the scope of our R&D agenda. All of our projects reside within one of eight strategic areas. They include.

1. Time Based Systems Engineering

    - Systems approach to reduction in product development cycles; cross-functional teams; utilization of CAD/CAE/CAM tools.

2. Information Control & Management

   - Intelligent manufacturing systems and machine control; advanced sensors; focus on ease-of-use, adaptability, flexibility, leading to higher productivity, quality, customer satisfaction.

3. Process Capability and Productivity

   - Improved process and equipment in manufacturing environment; improved understanding, focused process/equipment integration; "built-in" quality control.

4. Advanced Manufacturing Systems

   - Flexible approaches leading to reconfigurable concepts for manufacturing systems; attain short-run, high-quality, short turn-around production environments.

5. Advanced Materials Applications

   - Introduce new materials for product or process improvements; focus on technology developments that enable cost-effective, timely application of new materials.

6. Manufacturing Skills/Education Improvement

   - Provide programs and training for manufacturing personnel -- hourly, engineering management.; offer financial incentives to individuals and educational institutions to commit to manufacturing programs.

7. Technology Management

   - Provide technology transfer function over all phases of NCMS programs; develop industrial models and training for corporate technology development and implementation.

8. Supplier Chain Management

   - Establish joint needs of supplier-buyer, small company-large company relationships to facilitate technology, co-developments and communications (E-mail, EDI).

As we work on the projects that we currently have underway we are attempting to establish a comprehensive R&D agenda (more far reaching than the translation of Japan's R&D game plan, which I showed to you). Where we can, we are working with government and academia, so that our nation can have a single plan available on manufacturing technology needs. In addition, we have underway a data collection effort designed to capture information on the status of manufacturing technology and research on manufacturing technology worldwide. This, in and of itself, is a significant effort that should provide immediate benefits to our members and the U.S. manufacturing community.

We know that the research we sponsor is important, but we also know that to be of benefit it must be adopted and implemented. Accordingly, we place a strong focus on effective technology transfer. To help guide our efforts in technology transfer, NCMS undertook a thorough examination of the technology transfer successes and failures. I have a report here that documents the findings and points out the principles to success.

The study revealed that successful technology transfer is a continuous process requiring the transfer of "knowhow". This is accomplished with extensive personal contact and interaction. Reports on technology, no matter how good, tend to collect dust in a bookcase. We have also found that propinquity affects personal contact in small, medium and many large organizations. These two factors have influenced us to take several actions.

First, later this year we will focus the results of some of our related research into a production mode demonstration of prototype technologies. In addition to debugging the working interrelationships, we hope to train or retrain/educate both production workers and frontline management. We would like to accomplish this in concert with our R&D contractors and our institutions of higher learning. When this proves successful, we plan to expand the program to other sites across the country on other related manufacturing technologies. Based on our current R&D agenda, our membership envisions a need for between fifteen and twenty such facilities.

Second, even with production mode demonstration centers, our coverage of the nation's manufacturing industries will not meet the needs we anticipate. Therefore, we are presently conducting a study of all technical assistance, economic development and demonstration centers around the United States. There are approximately 150 such institutions in existence under a variety of federal, state, local, academic and business control. We will be developing a plan to work with the appropriate institutions to effectively propagate what we have learned. Incidentally, we would interface with your technology extension program here.

And this leads me to the last topic which I wish to address, the technology programs of the Department of Commerce. My short answer is that they represent a great start, but they simply do not go far enough.

Let me start on the research side. To the best of my knowledge, the Advanced Technology Program established by Congress last year remains unfunded. As a person who is working hard to help restore competitiveness to our manufacturing industries, I understand the importance of R&D and their true costs. I have difficulty understanding why this important and precedent setting program does not have the proper support.

Permit me to point out that numerous studies have looked at the amount of non-defense R&D that we undertake as a percent of GNP. when compared to our trading partners, we are underspending them by 0.9 percent of GNP. That is a lot of research. If my math is correct, on a relative, not absolute basis, we are underspending our trading partners by up to $40 billion annually. To make matters worse, recent documents we have translated from Japan indicate that the government is encouraging the typical manufacturing organization to increase its internal R&D to 25 percent of total staff and a proportionate increase in costs by the year 2000.

R&D is becoming more, not less important. So where is the money going to come from? Well, I can tell with a fair amount of certainty that our manufacturing industries do not have $40 billion extra sitting around just looking for R&D projects. And I guess that it is a safe bet that the government does not have it either. However, I surmise that if we could establish a real partnership, we could find enough together to make the difference.

For the sake of argument, let us assume that we can find the money. What do we spend it on? Based upon what has been suggested in the U.S., I am afraid that I do not have a good answer. At NCMS we have a plan for manufacturing technology but the United States does not have an overall national technology plan. Japan has a plan, but the United States does not. Nobody, no individual, no organization in the United States has taken the time to develop a plan. What is worse, is that without a whole lot of effort, you cannot even determine the status of a single technology. We need a comprehensive and thorough technology status and plan for the United States and we need it now. With respect to manufacturing technology, industry cannot wait, so NCMS is developing it now. We hope to have a good first cut before the end of this year.

The technology extension program is an excellent idea. However, to be effective, it must be substantially more than a toke effort. Earlier, I pointed out that in Japan, the technical assistance programs and centers exist at all levels of government, as well as within the private sector. What NCMS has found and what the Japanese already know, is that to be highly utilized and effective, they must exist in close proximity to the organization needing the help. We have estimated the effective radius of travel at approximately 100 miles. This implies a broad network, probably integrated and able to tap centralized sources of knowledge.

In my view, we do not now, not with programs that I am aware of, have the capability in this nation to consolidate educate and make available information and know how. At best, we have an inefficient system that results in random hits and misses. It is not sufficient to contribute to an industrial success in a global economy.

Before I go on too long, I would like to summarize my thoughts. There are no silver bullets out there. If there were, you and I would have found them by now. so we have to stop looking for silver bullets and get on with the business of solving our competitiveness problems. And we are going to have to solve them working together, not either of us working alone in a vacuum.

I began my remarks by citing an example of the type and level of cooperation undertaken by our trading partners. I did this for a very specific reason, our trading partners have found a better way. Like it or not, cooperation works better than adversarial relations.

At the National Center for Manufacturing Sciences, we know that it is possible to work cooperatively amongst industry. We think that it is possible for industry and government to get on a single team. I think that it is time we do it, not with lip service, but with deeds.

We have to put on the table all the issues that impact competitiveness, like product liability, tax policy, trade policy, intellectual property rights laws, training, education, technology awareness and a host of others.

We must work together to make all the changes necessary. This includes an adequate technology extension and assistance program that can reach the many hundreds of thousands of companies that need help. And we must provide the resources to have a strong and wide ranging technology plan and development program. A program not unlike the Advanced Technology Program but with greater industry input, less micro management and a significantly higher financial ceiling. A ceiling commensurate with the magnitude of the problem. I would also like to see funds made available in grant as well as contract and cooperative agreement form.

Mr. Chairman, I am not asking you to bail out losers or to pick winners. I am asking you to create winners by creating the environment in which ideas can be nucleated and nurtured, companies can grow and strengthen and become and remain competitive. I am asking you to invest in our companies, our industries and in America. The choice is yours.

The CHAIRMAN. You are exactly right about that virus of picking winners and losers, that cropped up 10 years ago during the Carter Administration, when we were told that we were becoming a service economy. Forget about manufacture, it was filthy anyway do not worry about it, get out of it, and then came picking winners and losers.

Actually, it was recommended at that particular time. I personally do not think we should do either one, but we have to have, as Ms. Hubbard described it, some kind of guiding hand from the government so that we can compete in this global market

Are you endorsing the AEA proposal, with respect to advanced technology?

Mr. MILLER. I think, Mr. Chairman, if you create the environment in which industry can flourish, that particular proposal will take off.

The CHAIRMAN. Ms. Hubbard, I am glad you clarified the $1 billion request of the American Electronics Association, and they will keep beating up on you for quite a while. But you keep preparing and you will beat them down, I would predict in the final analysis.

Mr. Weinert, we would like to appoint you as director of the Bureau of Budget. What we are trying to do is to change around our priorities. I cannot get it through to the Commerce Department. I cannot get them to even ask for it. They get off onto their sing-song of winners and losers, and we do not want to put industry on the public dole, and all of that kind of nonsense.

I like to get the industrial crowd in behind DARPA and identify promising industries. Defense has the biggest budget just look at the billions, of all your agencies. I know because I am on the Defense Appropriations Subcommittee.

It has been an outstanding presentation here. Let me yield to Senator Gore.

Senator **Gore**. I agree with your assessment, Mr. Chairman. I do not know when I have heard more interesting testimony. And I want to congratulate you for calling this hearing and for your longtime leadership on these subjects that we are discussing here.

You know, HDTV has been kind of a sub-theme throughout today's hearing. And Ms. Hubbard, I am wondering if the AEA has had an opportunity to look at the legislation that I introduced a few weeks ago? It would require the Department of Commerce to report back within 90 days on a comprehensive plan for government's role in cooperating with industry and universities in making the United States a more effective competitor in this critical technology. And it also specifies, in some detail, exactly what that report has to include.

Have you had a chance to review that?

Ms. **Hubbard**. We have actually looked at it and have it going to a committee next week. But I think, actually, the review is probably not the issue. I think the intent is absolutely commendable, and I believe that it is already getting a response.

Senator **Gore**. Is it getting favorable response?

Ms. **Hubbard**. Well, from the parties intended to sort of stimulate some action, yes.

Senator **Gore**. Oh, I see what you mean.

Ms. **Hubbard**. And so I think its purpose is actually being accomplished.

Senator **Gore**. Very good. I look forward to working with you all in the future on that. And, of course, as I said earlier, the Chairman had the first hearings on this whole subject, and really has played the critical leadership role on it.

Mr. Fluke, I enjoyed your testimony quite a bit. When we look at the success in Japan, we sometimes are led to the story of Dr. Demming. And the popular version of Dr. Demming's contribution focuses on quality control, but really, he places a greater emphasis on statistical analysis and on the kind of feedback that careful metrology, a careful measurement, can give a company that is interested in improving performance.

You say in your testimony that the United States now has no standards and measurement capability in several measurement areas important to U.S. industry. What are those areas?

Mr. **Fluke**. Well, I have described them in their fullest extent and quantitatively, of course, it would take a lot of time. That is why I referred you to this National Measurement Requirements Committee report that enumerates those in great detail.

Senator **Gore**. Oh, I see.

Mr. **Fluke**. They are the better part of 100 to 200 areas, each of which consists of several different measurement capabilities that we are either light in or, in some cases, cannot do at all. It is not so much the point as to whether we can do it at all under carefully controlled circumstances as it is that the routine availability of acceptable levels of uncertainty find U.S. industry often going offshore, not so much just because the price is right, but because it is where the fastest turnaround might be available, the lowest levels of routine uncertainty can be obtained without special handling and that sort of thing.

And you are right. This is crucial not only to the traditional primary standards and their function in industrial concerns in making sure that the quality assurance inspector can check the product once it is all put together and ready to ship.

What we have finally begun to discover in U.S. industry is something, of course, that you characterized as having been taught to the Japanese by our Dr. Demming. And that is, in a nutshell, the reason why higher quality approaches to controlling processes in manufacturing work so well.

And the reason why quality is "free" is simply the reason that was mentioned here by one of the other panelists. And that is that if you adopt a manufacturing process that is founded on the idea that we did not have time to do it right the first time, but we have time to do it over, not to mention the personnel you hire and put in place to check on what was going on, those people do not add any value, they simply occupy space and room on the payroll, it all adds up to a non-competitive picture.

Senator **Gore**. Yes.

Well, you know that we find that a lot of times, these new advances take place and the private sector just does not take advantage of them. Yogi Berra once described a phenomena by saying, "What we have here is an insurmountable opportunity."

You know, just time and time again, American industry seems to be confronted with an insurmountable opportunity. And the chairman's legislation, now embodies in law, and today's testimony partly consists of a report on its success, is really designed to make it possible for those opportunities to be seized.

There are two key components to it. One, is the translation of basic research into recipes for productivity enhancement. And that is what we are talking about. And the other is education. And you came back to the subject, Mr. Weiner, in your testimony. And it is not the fault of Japan that we have a 28 percent drop-out rate, while they have a two percent drop-out rate.

In that context, we should see their competition as a blessing, forcing us to face up to some fundamental failures here in the United States that we have simply got to address.

I do not pretend to have all the answers on that problem. The chairman and I were talking about it earlier. An awful lot has to be done. I do believe that the network, of which I am so fond and which I have discussed here before, does, in fact, offer some opportunities to improve the productivity of education itself.

My children and I watched the movie Stand and Deliver the other night, a wonderful movie about Jaime Escalante, a mathematics instructor in East Los Angeles, who worked what many saw as a miracle, but really was the result of just hard work and good teaching from somebody who had commitment.

We cannot replicate Jaime Escalante, but we might be able, with expert systems and a high-capacity network, to give interactive programs to schools that might embody the essence of some of the successful techniques used by excellent teachers like Jaime Escalante.

And, you know, when you look at the potential for computers in education, it seems so vast; you look at the reality and it seems so sad. We need to change that, along with many other changes in the teachers' salaries and attracting more talented people into the profession, and all of the other changes that the experts in education policy talk about.

I would just like to conclude, Mr. Chairman, by saying a word of thanks to Dr. Paul Huray. He comes here to us today wearing the hat of the vice president for research at the University of South Carolina, but, as has been mentioned, he was also the chairman of the Federal Coordinating Committee on Science and Technology that reviewed this proposal on the supercomputer network, the Information Super Highway proposal, and was kind enough to take time off and join me when the legislation was introduced a few weeks ago—I mention that as well.

And Dr. Huray, I want to congratulate you and your colleagues on that panel for the outstanding job that you did. And I am much comforted that you are still very much involved in the larger policy area of how we can make the United States more competitive. I wish you were still at Oak Ridge instead of Columbia, South Carolina.

But we are content to be a part of the Southeast region, where you influence is so particularly helpful.

In any event, I join the chairman in complimenting all of our witnesses today. I think it has been a really good hearing.

Thank you, Mr. Chairman.

The **CHAIRMAN**. Thank you.

I join, too, in thanking this entire panel. Dr. Huray, we appreciate it. And we are going to move that legislation along. His interdefense highway system of communications I think is a splendid idea. As for HDTV, the legislation might get hung up on the House side and the Administration—I have been wanting an answer, and I have told Secretary Mosbacher, this month.

Because it is quite obvious, that with high definition television, or ATV, that the applications are far more for commercial and for industrial competitiveness and our economic security, than our military security. And we want him to move the Secretary on and get an answer there.

We need to move on every particular front, and not just in a Pavlovian fashion. You come up here from industry and want $1 billion. That is not the case at all. We are trying to play catch up ball.

Mr. Miller, I went into the automobile industry back in 1984, in that Presidential campaign. I did not even get beyond New Hampshire. But, in any event, I did get to Detroit, and low and behold the Japanese were financing the robots. Giddings & Lewis, Cincinnati Millicron have a better robot, but we could not finance it. In fact, they were financing the State of Michigan so that they could have a $500 million line of credit on the New York financial market.

So there you are. We have tremendous competition but all of us know, the private free enterprise system is the key. It has been a success, and no one is trying to imitate a MITI, but in some measure, we have got to meet that international competition.

By the year 2000, the Pacific Rim GNP will exceed that of Europe and the United States combined. Now that is the kind of competition that we face. And we can sit back here with these little chamber of commerce political talks, but we are not going to get anywhere. We can go out of business in that fashion.

And so, what we are doing is trying to jazz up our government and say the need for government is just as great today as it was 200 years ago, only instead of building the cities, we have got to free them from drugs and crime. Instead of felling the forest, we have got to preserve them and our environment.

It is a wholly different role. But the cry has been out there from this crowd downtown now for over eight years running, that the government is the enemy and we do not need it. We are running out of gas on that score. And I think the panel's presentation here this morning just highlights it. And I am very, very grateful to you.

Do you have anything?

Senator Gore. I would add one brief word. Your comments on robots was interesting. On the House side, we had a hearing a few years ago on robots. And we found the civilian research budget was being cut while the defense robotics budget was being increased dramatically. And it got to the point where the defense budget for robots was 10 times larger than the civilian R&D budget for robots.

And I recommended, at that time, that we reverse that priority, and then, in time of war, draft the robots in case they were needed.

Thank you, Mr. Chairman.

The Chairman. Thank you all very, very much for your appearance here today.

[Whereupon, at 11:55 a.m., the hearing was adjourned.]

[The following information was subsequently received for the record:]

STATEMENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The Committee Force on the National Institute of Standards and Technology of the American Society of Mechanical Engineers (ASME), appreciates the opportunity to present our views through this written statement to the Senate Commerce, Science and Transportation Committee regarding reauthorization of Commerce Department technology programs for FY 1990. This statement was prepared by the ASME/NIST Interaction Committee and represent the consensus of that group rather than an official position of ASME. This statement was also presented verbally to the House Subcommittee on Science, Research and Technology during their hearings in March, 1989 on the FY 1990 budget request for the National Institute of Standards and Technology (NIST).

Founded in 1880, ASME's membership of 116,400 engineers, which includes 19,200 students, practice many applications of engineering. As a result, we have a strong and continuing history of interest in both the immediate and long term direction of NIST.

In fact, NIST recently released a report which outlines several areas of interactions between NIST and ASME. A copy of the report is attached to this statement and we request that it also be included with our statement in the record of this hearing.

One of the most important aspects of NIST's work is technology transfer. In order to commercialize new technologies, standards must usually be developed. If the necessary standards do not exist, they must be developed and tested. Therefore, the importance of standards cannot be overemphasized in industrial competitiveness. Standards provide the basis for technology transfer because they allow companies to manufacture products based on proven specifications. NIST plays a key role in this area of standards and technology transfer and we hope their efforts in this regard will continue and be strengthened.

However, despite all the actions which signal the increased interest and responsibilities of NIST, the FY 1990 budget request calls for an overall budget reduction of nearly $4 million, falling to $155.6 million from the $159 million FY 1989 appropriation. Funding for NIST has not kept pace with the level of responsibility it has been asked to assume. Therefore, we are greatly concerned that without increased funding, NIST will be forced to cut its critical on-going work to pay for the new programs. Ideally, we would like the Administration to commit itself to a far-reaching, long-term growth plan for NIST, as it has for the National Science Foundation.

In FY 1988, Congress appropriated $144.8 million for NIST. In FY 1989, NIST requested $158 million from Congress--and received $159 million. However, it should be noted that the $159 million included $15 million for program activities that were not included in the budget request. As a result, in FY 1989 the portion of its budget which is directed to the traditional NIST activities is only $144 million.

While ASME went on record as favoring funds for the Regional Centers for the Transfer of Manufacturing Technology, formerly known as the Hollings Centers, we do not support the manner in which $7.5 million in funds were "earmarked" by the House Appropriations Committee for this activity in the NIST budget. Likewise, the $7.5 million for an NDE Center grant, which was not in the budget request, was at the expense of proposal initiatives and other important programs. Funding for the newly authorized programs should be in addition to funding for the base programs and new technical activities. If we continue to fund the newly authorized programs at the expense of the base technical programs and initiatives, NIST programs will suffer and they will not be able to address the important technical issues associated with emerging technologies which are critical if we are to further our Nation's industrial competitiveness.

Regarding the specific areas of the NIST budget, our comments focus on the areas of proposed increases and decreases in the budget. Please do not assume that the areas we do not address are not important.

We certainly understand and appreciate the vital role that NIST plays in the technological battle currently being waged, particularly between the U.S. and Japan. Their work is especially important since as previously discussed, NIST not only conducts research, but plays a vital role in moving research out of the laboratory into the hands of industry. But again, we want to emphasize that new NIST activities should be funded adequately on their own merits, and not at the expense of important "core" programs.

For example, for the seventh year in a row, the NIST budget proposal has called for drastic cuts in the fire and building research programs. We strongly disagree with the Administration's contention that this important work will be picked up by the private sector. Unfortunately, the debate on fire and building research has become an annual event. As a result, time and attention needed to save these programs have diverted attention from other areas of the NIST budget with which Congress should be concerned. Nonetheless, we once again join in this debate and ask that you reject the proposed cut of $3.9 million and fund the fire and building programs at a level consistent with previous years.

Another area of concern is the elimination of another fire and building research program, searching for alternative refrigerants. The proposed cut of $250,000 comes at a time when we are faced with an urgent need to replace widely-used refrigerants that damage the stratospheric ozone layer. While the budget proposal states that "this program is inconsistent with funding priorities for NIST for FY 1990"--we think it is consistent--and should be continued.

We are quite pleased, however, by the proposed $700,000 increase for the High Temperature Superconductors program. Building on funding from FY 1988, NIST is fulfilling its role specified in the Superconductivity Initiative. Among other things, that initiative called for NIST to develop superconductor standards, and establish a superconductivity center at NIST for electronic applications. The superconductivity center has already been put to its test. With the discovery of high temperature superconductors, NIST introduced the first superconducting measurement device (SQUID). SQUID, a superconducting quantum interference device, is capable of operating at liquid nitrogen temperatures and is fully recognized as a measurement device.

As you know, world-wide competition to develop and market products based on superconductivity is extremely fierce. NIST can and must provide the necessary research on measurements and standards related to superconductivity to speed the commercialization of superconductors and help assure the U.S. competitive position. We strongly support this programmatic increase.

We also are in favor of the $2.6 million requested for the Lightwave Measurement Technology Program. Mechanical engineering is involved in virtually every aspect of lightwave technology. NIST has already provided the measurement basis for 25 voluntary industry measurement standards that support the development and sale of optical fibers. It has been estimated that the economic benefits of this program will reach $100-200 million per year in the next decade.

We are also very much interested in the Bioprocess Engineering program and support its proposed increase of $2.3 million. Mechanical, as well as chemical engineers will be faced with many challenges by new and emerging technologies related to the biotechnology field. While there is general agreement that the U.S. currently leads in fundamental biochemical research in the laboratory, we must improve our capability to move this technology into the marketplace. NIST can play a key role in developing the necessary measurements and standards which will allow the U.S. to be competitive in the many commercial applications of bioprocess engineering. We support NIST's activities in this area.

We would also like to go on record as supporting a two-year budget authorization for NIST. This would allow for better long-term planning and eliminate much of the guess work that currently takes place with a yearly authorization. Long-range planning is absolutely critical to meeting many of the technology and competitive challenges that the U.S. faces today. For example, as you know, the Western European countries plan to incorporate their markets into a single integrated market by the end of 1992. There is considerable concern in the United States regarding differing national technical standards and their implications for U.S. exporters to Europe. This area could have a significant impact not only on the standards work at NIST, but in all of the competitiveness areas we have outlined.